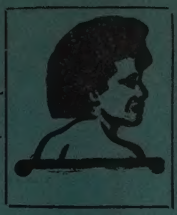
VOL. 25 NOS. 1 AND 2 MARCH, 1954



COLONY OF FIJI

AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI

ANNUAL SUBSCRIPTION : SIX SHILLINGS

GOVERNMENT PRESS, SUVA, FIJI

Notes for Libraries and Research Institutes

FORMER ISSUES OF AGRICULTURAL JOURNAL

So many requests are received from abroad for parts of the " Agricultural Journal " which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part :—

Vol.				Vol.			
1.	3	numbers,	1928.	14.	4	numbers,	1943.
2.	4	,,	1929.	15.	4	,,	1944.
3.	3	,,	1930 (none).	16.	4	,,	1945.
4.	4	,,	1931.	17.	4	,,	1946 (none of No. 1).
5.	2	,,	1932 (none of No. 2).	18.	4	,,	1947 (none of No. 1).
6.	2	,,	1933.	19.	4	,,	1948 (Nos. 3 and 4 form a double issue).
7.	1	,,	1934.	20.	4	,,	1949.
8.	4	,,	1935-7 (none of No. 4).	21.	3	,,	1950 (none of Nos. 1 and 2 combined).
9.	4	,,	1938 (none of Nos. 2, 3 and 4).	22.	1	,,	1951.
10.	4	,,	1939 (none of Nos. 2 and 4).	23.	3	,,	1952. (one double issue).
11.	4	,,	1940 (none)	24.	2	,,	1953. (two ,, ,,).
12.	4	,,	1941 (none of Nos. 1 and 2).	25.	2	,,	1954. (two ,, ,,).
13.	4	,,	1942.				

ISSUES OF AGRICULTURAL CIRCULAR

NUMBERS and year of issue of the " Agricultural Circular " :—

Vol. 1, 1920, 12 numbers.
2, 1921, 5 ,,
3, 1922, 4 ,,
4, 1923, 1 number.
5, 1924-5, 2 numbers.

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS

FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

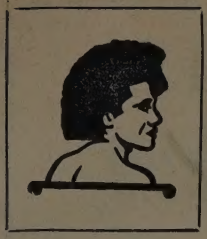
No. 1. Sisal Hemp in Fiji, 1911.
3. Rhinoceros Beetle in Samoa, 1912.
4. The Banana in Fiji, 1912.
5. Scale Insect on Bananas, 1913.
6. Lemon Grass, 1913.
7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
8. Coconut Experiments, 1915.
9. Soils of Fiji—I, 1916.
11. Alluvial Soils of Fiji, 1919.
12. Leaf Moth of Coconuts, 1919.
13. Sea Island Cotton, 1920.
14. Transparent Coconut Scale, 1921.
15. Purple Leaf Moth of Coconuts, 1924.
18. Control of Coconut Spike Moth, 1935.

The following are available to the public at the prices shown—

No. 21. Biological Control of the Rhinoceros Beetle, 1941. Price 1s.
21A. Fijian Plant Names, 1942. Price 3s. 6d., 4s. and 6s.
22. An introduction to the Mosquitoes of Fiji, 1943. Price 1s.
23. Insect Pests in Fiji, 1946. Price 1s.
Gardening Notes, Insect Pest Control and Plant Diseases, 1945. Price 1s.
24. The Botanical Gardens, Suva, 1948. Price 1s. 6d.
25. Observation on Copra Drying and Copra Dryers, 1950. Price 1s. 6d.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR



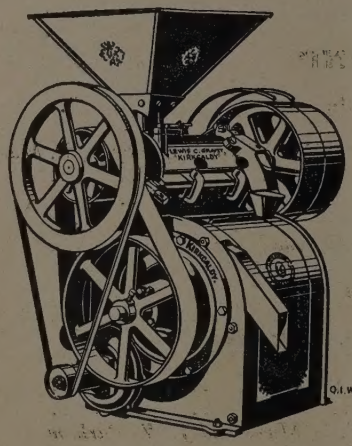
Agricultural Journal

VOL. 25 MARCH, 1954 NO. 1

CONTENTS

ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI.

PLANTERS MILLS
BY GRANTEX
For Edible Rice in one Operation

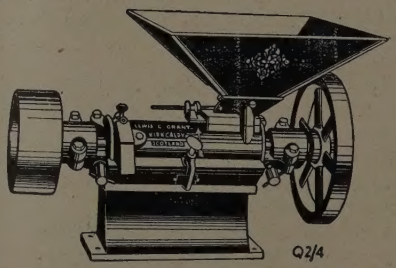


No. 1 RICE HULLER

Output of cleaned Rice per hour from Paddy	500- 650 lb
Output of cleaned Rice per hour from Shelled Rice	1000-1300 lb
Driving pulley	12½" x 5"
Speed Revs. per minute	600- 750
Power required, B.H.P.	15
Approximate gross weight	700 lb
Extra weight if fitted with fast and loose pulleys	95 lb
Extra weight if suction fan fitted	50 lb
Approximate shipping measurement	30 cu. ft.
Output of cleaned Rice per hour from Paddy	80- 100 lb

No. 4 RICE HULLER

Output of cleaned Rice per hour from Shelled Rice	160- 200 lb
Driving pulley	8" x 3"
Speed Rvs. per minute	750- 900
Power required, B.H.P.	4
Approximate gross weight with low stand	180 lb
Approximate gross weight with high stand	210 lb
Extra weight for fast and loose pulleys	30 lb
Approximate shipping measurement	30 cu. ft.



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THE FARM INSTITUTE

The Koronivia Farm Institute, at which field officers will be trained for the Department of Agriculture and which will be available for courses for farmers generally, was opened on Thursday, 8th March, 1954, by Sir Geoffrey Clay, K.C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State for the Colonies.

EARLIER SCHOOLS

The principal of the institute, Mr. N. Lamont, said that agricultural training had been given before the war at Nasinu and Naduruloulou and most of the senior field assistants who were now doing such valuable work were graduates of these earlier training schools.[1]

At Koronivia there was provision for 20 resident students. The course covered two years, so 10 students had been enrolled this year and another 10 would be added next year.

Mr. Lamont said he hoped that the Institute would be used for refresher courses for the field staff of the Department and that agricultural courses for farmers could be held while the students were on holidays.

COLONY'S PRODUCTION

Before opening the institute, Sir Geoffrey Clay said:

"I have had the pleasure in the last month of seeing something of this beautiful Colony of Fiji, with its present impressive volume of agricultural production and, if I might say so, its still untouched reserves of land and labour which, properly used, could increase greatly both in volume and variety the wealth of agricultural production of the Colony.

I have been impressed, as must any visitor be, with the value of an organization such as the Colonial Sugar Refining Company in which the benefits of capital investment and efficient overall management are applied to peasant or small scale farming with impressive results, and I have seen also the subsistence farming of the unorganized peasant agricultural producers.

CONTRASTING SYSTEMS

I have also seen the contrast in the case of certain perennial crops between estate production, and peasant production lacking. if I might say so, the factor of management which in any industry is one of the essential components of efficient production."

"I have also been impressed with the basic structure of the Fijian people with its communal ownership of land, its communal obligations and loyalties and conversely its sanctions and should I say disincentives to production.

I realize fully the great concern felt by those who know the Fijian people and love and admire their fine personal characteristics, their prowess in the field of sport and their bravery and outstanding record on the battlefield, and believe that this communal loyalty and the undoubted social benefits which communal life can give to the individual should be so moulded and its evolution so guided that community development can be a vital factor in the economic advance of the Fijian people in addition to its value in the social field.

FUTURE EXPANSION

Many of us concerned with agricultural production in the Colonies feel that ultimately, with the accumulation of experience and the acquisition of capital and the development of commercial acumen, there is no reason why the individual members of the indigenous people of the Colonies should not develop as large-scale operators in the fields of agriculture and industry and commerce.

In passing I would refer to the positive influence in this direction which a mixture of large-scale agriculture with peasant production can exert by demonstration, such as is present in Fiji with its large copra plantations, yet many of us feel that if peasant agricultural production is to progress in any degree towards the efficiency of large-scale plantations or estate production some form of group organisation is essential into which can be injected economic investment of capital and—equally important—management.

SOCIAL ORGANIZATION

For these reasons I feel that the Fijian social organization can, if properly guided, provide the medium for this advance in efficiency of production.

But, as we know in the case of British farming, the efficient producer in the last 50 years has had to give up social activities, pleasant as they may be, in order to devote his attention to the problems of farm production in an age in which economic necessity has forced a rural society to pay attention to farm costing, time and motion studies, labour-saving devices, etc., and has modified farming as a way of life, with time for country fairs, hunting, market days and rural feast days, into, in some some cases, a fairly highly competitive industrial undertaking.

But, it might be asked, what has all this to do with the Farm Institute ?

TRAINING GROUND

In the first place, this institution will provide the training ground for the future lower echelon field staff of the Department of Agriculture and Veterinary Services and in their two years' residence here the students will acquire not only a knowledge of some of the arts and sciences which if applied make for efficient land use and agricultural production but will take away with them a picture of a visual demonstration of these arts and practices in the fields of livestock and crop production with which they will have lived for a brief but formative period of their lives.

I am very pleased to learn that students will also be given forestry instruction as part of their course in co-operation with the Forestry Department for the role of forestry in land use planning and in rural economy cannot be overstressed.

I understand that many of the students at this institute will be drawn from the Ratu Kadavulevu School, and here I would wish to stress the importance of associating with such educational centres the development of efficient, planned land use in an agricultural country. All educated men —and women—no matter into what branch of life they finally find their vocations, should have some appreciation of the pattern of land use and the system of agriculture best fitted to that land-use pattern.

I am happy to pay a tribute to the obvious importance and the efficiency with which Mr. Bay and his staff are developing the large agricultural estate at the Ratu Kadavulevu School and the happy relationship which exists between the Education Department and the Agriculture Department in this field.

But it is not sufficient to keep up a staff of agricultural and livestock extension workers and expect them alone to have the responsibility for agricultural betterment. This is particularly so in the Fijian reserves now being demarcated in the Colony, where the scattered nature of the koros and the difficulties of communication make it impossible for the extension staff of the department to pay other than infrequent visits to the individual villages.

It is obviously important that the leaders of Fijian life, be they Roko, Buli or Turagani-Koro must be sympathetic towards and be active agents for stimulating improved agriculture production and better land use. I was, therefore, pleased to hear from Mr. Harvey that he hopes that it will be possible in the vacations at the institute to organize short courses for chiefs and Fijian Administration Officials and other leaders of Fijian Affairs.

I can testify from my experience in other parts of the Colonial Empire to the value of such courses and hope that the Government will be sympathetic to such development.

I will also stress the importance of the primary school teacher in rural life and the desirability of such agents in rural uplift not only in their limited sphere as teachers of the young but also as people of influence with parents and the older people in rural areas having some appreciation of the aims and objectives of agricultural and land use policy.

The ideal would of course be for the Teachers' Training College to be alongside the Farm Institute, but if this is not possible I hope that opportunity will be afforded at some stage of their training for teachers to visit this institute either for short courses or, if this not is possible for excursions and talks by the staff."

Sir Geoffrey went on to emphasize the importance of agricultural extension work among Indian farmers and he said that he hoped that all races would take advantage of any general courses organized at the institute:

EXPERIENCE IN ENGLAND

He concluded:

" It is now some 42 years since as a farm boy I started my professional career as an agriculturist. That training began at a farm institute in my own country of Lancashire, when I attended a six weeks' dairy course after which my education proceeded with an appreciation of what efficient farming can mean, not only as a desirable way of life but as a thing of beauty and a picture in which I still feel I should like to be included if and when retirement from a professional agricultural career permits.

AIM OF INSTITUTE

However, I trust that this institute will equally impress itself on the minds of the students who pass through its doors and see its livestock and crops.

Finally, I should like to pay a tribute to the design, fittings and construction of the institute buildings.

Might I suggest that the motto of the institute or its guiding principle should be that of the Royal Agricultural Society of England, which, by its examinations for the national diplomas in agriculture and in dairying, has influenced the philosophy and curricula of farm institute in Great Britain. That motto is ' Practice with Science '."

REFERENCE

1. 1946. Parham B.E.V., Agricultural Training Scheme *Agric. Jour.*, Fiji. Vol. 17 No. 4—112.

AGRONOMY . . .

SOME COMPARISONS BETWEEN RICE GROWING IN MALAYA AND IN FIJI

BY R. R. MASON

The writer recently spent a month in Malaya in order to obtain first-hand information on the progress being made there in mechanising the rice crop. This subject of mechanisation is under active study at the Principal Agricultural Station, Koronivia, and it is hoped to publish an interim report after this season's work. The present article deals with the similarities and the differences of rice growing by peasant methods in the two countries.

The Federation of Malaya is of course very much larger than Fiji, yet although it stretches from one degree north of the equator to nearly 7° North, the climatic differences are little greater than between the west and east sides of Viti Levu. The main mountain range extending south from Siam effectively divides the country into two, and it is on the coastal plains and lower valleys that rice is grown. On the west coast, which is the more important area since it has the tin mines and most of the rubber plantations, there is a vast coastal plain in the northern states of Perak and Kedah. These two states grow most of Malay's rice. The rainfall is around 90 inches and is concentrated into two peaks with intervening dry seasons. In central and southern Malaya the seasonal fall is much less marked, and a dry season is scarcely definable, as any month of the year may be wet. Consequently the time of planting rice is much more variable.

The coastal plain becomes narrow in the south, and in Malacca and Negri Sembilan padi is grown in smaller areas in valley bottoms under conditions similar to Fiji's wet zone. These two states together contribute only 7 per cent to the total acreage; yet each grows about 30,000 acres—as much as the whole of Fiji.

On the east coast, in the states of Kelantan and Trengganu, wet and dry seasons are very clearly defined, for the climate is monsoonal. On the west coast the soils of the padi-growing areas are all fairly heavy clays, and only a negligible proportion of the total padi crop is grown on dry land. But the valley of the Kelantan river is not nearly as flat as the coastal plain in Kedah, and the higher patches will not collect and hold water for wet padi growing; in places, wet and dry fields alternate almost like the square of a chess board. Wet padi is grown where possible, since on the average it yields 50 per cent more. In one area it is even grown on sands, for a well-developed pan holds up the water. Keletan soils are frequently lighter than those of the west coast, and some areas have recently been shown to give striking responses to artificial manures, which rarely benefit wet padi.

The majority of the country's rice is grown by the Malayan people, although Chinese growers are numerous in Malacca and the other old Straits Settlements. The Chinese are more industrious than the Malays and get better crops by paying more attention to cultivation and weeding.

Since the rice crop has been grown for very many centuries it is not suprising that there are upwards of two thousand named varieties, and that the technique of cultivation, and especially of water control, is sound.

In contrast, in Fiji the vast bulk of the rice is produced by a race whose stay in the country barely exceeds half a century. Yet in that time twenty or thirty suitable varieties have been found, and a suitable time and method of planting for each has been discovered. Some bad practices have been and are continuing to be followed in some instances, such as the ploughing of hillslopes in western districts for repeated crops of dryland rice, regardless of the principles of soil conservation and of the resultant erosion yet the main criticism of the peasant-farmers' methods here is the neglect of water control, of weed control, and of the selection of good clean seed.

There is in Malaya a shortage of available padi land, such as Fiji will it seems, soon be meeting. New areas of forested land are being opened up there, usually as irrigation schemes, but in many cases there are considerable depths of peat which is not very suitable although the underlying clay would be satisfactory if the peat could be got rid off. Fiji is fortunate in that almost all of her rice requirement can be grown locally, but the large urban populations in Malaya, together with the fact that both of the main races are rice-eaters, necessitate large importations.

To a visitor from Fiji, the most striking sight in the Malayan padi growing areas is the succession of tiny fields, each surrounded by a narrow bund enclosing a sheet of water. Where the land is not flat, each field may be at a different level. The bunds are only one to two feet wide, and besides being paths they provide grass which is cut and carried for buffalo fodder during the rice growing season when the animals cannot be allowed to wander. Bunds are thus kept clean, but it must be added that para grass does not grow freely except at higher elevations.

The Drainage and Irrigation Department has been the means of bringing irrigation water to many large areas. There is usually a reticulation of distribution canals and channels to the higher fields from which of course the water flows to the lower ones and thence to drains. In some areas (as in the Tanjong Karang irrigation area) small dams across the canals cause them to overflow and flood the adjacent land. This results in the lower lying land being under fairly deep water and the ground being too soft for buffaloes so that all work has to be done by hand. In such cases the weeds are hoed and raked up into heaps to rot under water. Seedlings for such areas are transplanted twice (first into shallow and then into deep water). In this area no control of water level in individual fields is possible, but this is unusual.

Methods of cultivation vary to some extent but ploughing is all done by buffalo. The plough itself is a simple wooden implement with a share but only a minute mould board, and is drawn by one animal. In Malacca it is used when there is an inch or two of water on the land. If possible the field is then flooded to about four inches and left about a fortnight. A primitive comb-like harrow is next used after letting off some of the water. The ploughing is sometimes repeated and the harrow used two or three times, the main object being weed control. Transplanting is carried out in about four inches of water and the seedlings are planted on the square in straight lines to facilitate weeding, which is given very much more attention than in Fiji. If there is no irrigation, flooding of the fields is dependant on rain and planting may be delayed; the consequent use of over-age seedlings than results in lower yields.

For harvesting, the grain is cut either with a sickle or a small knife, held in the palm of one hand; with the latter, individual heads are cut, and any that are still green can be left and cut later. The normal method of threshing after using a sickle is by holding the straw and beating the ears over bars fastened across the top of a half barrel, which is surrounded on three sides by screens to prevent loss of grain. If little straw has been cut, the grain is rubbed out by foot.

In contrast to the very high proportion of wet padi in Malaya, roughly half is wet in Fiji. But very little of this 16,000 acres is truly wet; the usual way of growing it is to plough with a pair of bullocks and an iron plough when the onset of the rainy season in October or November has softened the ground sufficiently. After using an iron harrow and ploughing again, the land is harrowed when wet until it is churned up into soft mud and the seedlings are then transplanted, being 4 to 6 weeks old. But a week's dry weather is enough to dry out and crack the mud except in the hollows where water stands; and in such hollows the yellowing of the leaves typical of rice yellows is frequently seen. Where bunds have been made, they rarely follow the contours, so that in effect it is only the flat and low-lying areas that retain water. Seed beds are established on dry land at the edges of the wet padi fields and there seems little difference in the seeding rate—namely up to a "tin" (kerosene drum—4 gallons) or about half a square chain for

each acre to be planted, Possibly the seed beds tend to be larger in this country. Wet seedbeds are used in some of the Malay States and floating seedbeds are constructed in places where flooding is liable to occur.

The rest of the rice is either sown behind the plough or broadcast; small areas are also sown with a grain drill. Yields are normally low, for a number of reasons. Hillsides are naturally poorer than flat land and wet padi can usually be grown on the flat land. With bad management slopes become poorer still through soil erosion, Weed growth especially of Muraina grass (*Ischaemum rugosum*) is frequently very heavy. Finally the crop may suffer from actual water shortage. However, drilled crops at Koronivia have in general given remarkably good yields—provided that the rice is part of a crop rotation and that continuous cropping of rice is not carried out. Response to nitrogenous fertilizer has been marked, whereas wet padi has not given consistent results.

The similarities between the two countries are great enough to indicate some of the improvements which could be effected here. Outstanding is the question of proper bunding along contour lines in order to give water control. Extension of wet padi growing to gentle slopes should not be difficult and would result in much better weed control. and would also allow continual cropping. While water will control weeds such as muraina and sensitive plant (*Mimosa pudica*) others such as sedges still have to be hoed, and more attention to their weeding would pay big dividends. The Malay farmers are fortunate in the fact that their Department has been able to set up a chain of small experimental stations which test out the varieties best suited to each district, and also conduct manuring experiments. In Fiji the best varieties for the wet zone have been established by trials at Koronivia and the use of pure seed of these varieties (which is available for sale in small quantities) gives much better results than unselected mixed seed of poor varieties.

RICE HARVESTER

This note describes the operation of the stripper during trials and demonstrations in the Western Division.

Locating suitable crops on which to operate presented the first problems, as prime requisites were:

(*a*) a fully ripe, unlodged crop;
(*b*) freedom from weeds;
(*c*) reasonable access to the crop for the machine.

Early in the season farmers were somewhat reluctant to take the risk of leaving a crop to the fully mature stage necessary for stripping, and in some cases their ideas of access would, if acted upon, result in disintegration of the machine before it reached the crop. Another pre-requisite was perfectly dry conditions, not usually attainable before 9 or 10 a.m. at this time of year.

In actual stripping operations it was found that much depended on the variety of rice and the conditions of the crop. A patchy crop of Bandala with straw varying from very fine to the thickness of a pencil proved impossible to handle. A light crop of Bandala was handled with better success and with a wider spacing of teeth in the omb. This results however, in some loss on to the ground of grain through the wider spacing, but the heads were well stripped and there was little choking of the comb. Seven bags were stripped from 1½ acres in nine hours, but a considerable portion of this time was spent in adjustments. An even crop of Ram Bhog, with light straw, promised fairly good results, but stripping had to be abandoned after a few rounds owing to soft state of the ground. Some later crops of China Patna have been selected for the next trials.

Results to date indicate that the machine is only moderately successful in handling rice crops. Apart altogether from lodging, most local varieties of padi seem to be weak at the nodes and bend over when the head is left to mature. This results in heads lying all ways at varying heights. which entails either missing the low-lying heads, or lowering the comb to a height where it cannot handle all the straw. Fully satisfactory results can be expected only in an up-standing crop of even straw. Some peasant farmers are dismayed at the loss of grain, slight under good conditions, but the more progressive farmers regard it as of little importance in comparison with the time saved. —A.D.M.

SMALL COPRA DRIERS AT RABI

The "Rabi" type of copra driers is at present being widely used throughout the island so that the large hot-air kilns erected some years ago by Messrs. Lever Bros. are now idle.

As more money is being paid for dried copra than green (previously copra was bought green by the Society and dried in the big kilns mentioned above), the islanders sought ways and means of building small driers to enable them to dry their own produce. The result is a modification of the large kilns. Instead of pipes, 44-gallon drums are used. The first drier was constructed about two years ago.

The general idea is to house drums lying end-on to form a large pipe within four walls with an opening in one wall through which the open end of a drum slightly protrudes. This becomes the "firing or furnace end" to admit the fuel which is burned directly inside the drums. At the opposite end, the side or the end of the last drum is pierced to take a short length of pipe about 4 inches in diameter and is long enough to carry through the wall at that end. This is the smoke stack.

The walls are made from pieces of corrugated iron and/or flattened-out biscuit tins. There are no air inlet pipes; possibly there are sufficient cracks and openings in the walls to compensate for the lack of those pipes.

The tray for carrying the copra is either fixed or movable, about 18 inches above the top of the drums and covers the area formed by the four walls. For the two-drum drier, it measures approximately 6 x 5 feet with a capacity of one sack of green copra.

There are three different methods of construction based possibly on the individual requirements but employing the same working principal.

1. One sack capacity, fixed tray, thatched shelter and using two drums.

2. (*a*) Two sack capacity, running vata, corrugated iron walls and roofs (more like an oven) and using three drums (trays required for large drier);

(*b*) double-decker trays, fixed, drying chamber enclosed by sacking hung from top plate with removable roof to permit sun drying as required.

3. As in 2 (*b*) but with two running trays placed one above the other and four drums, capacity four sacks.

Method of Operation—The copra is cut in the morning and placed in the driers about three o'clock in the afternoon when the fire is lit. Wood fuel is used as "bulus" (coconut husks) need too much attention. Four logs about four feet in length and 6–8 inches in diameter are placed inside the drums and allowed to burn until only the charcoal remains before the replenishment with another lot. Each charge of fuel lasts for roughly two hours and by ten o'clock the fire is allowed to die out and by morning the islanders claim the copra is dry. There is still a certain amount of heat in the kilns by morning owing to a number of rocks that have been placed next to the drums which still give off heat long after the fire has died out.

—L. HARMAN.

ANIMAL HUSBANDRY . . .

VAIVAI* AS A FODDER FOR CATTLE IN THE DRY AND INTERMEDIATE ZONES

Vaivai is a deep rooted perennial shrub, related to sensitive plant and *Desmanthus*. In Hawaii it has long been established as a fodder crop, and has been found to be a particularly useful cattle feed in the dry and intermediate zones. It is undoubtedly a very valuable fodder as analyses show that it has a higher crude protein content than lucerne. According to Hawaiian workers the leaves contain 30 per cent and the young stems 22 per cent of crude protein on a dry matter basis, and it yields 20–30 tons of wet material per annum.[1] During the drought this year (1953) at Sigatoka it has been very noticeable that vaivai was still growing well and producing valuable fodder when many other grass and legume species were completely dried out. Experiments in Hawaii have shown that dairy and beef cattle find it very palatable and thrive on it, but it should not be fed to breeding pigs or to horses, as it contains a substance known as mimosine that affects the breeding cycle of nonruminants and also makes their hair fall out. One pig breeder in the Colony, has, however, been feeding it to his fattening pigs, and he claims that it is an exceptionally good green feed. As it is so drought resistant and has such a high crude protein content an attempt has been made at Sigatoka during the last two years to grow it as a drilled crop on a field scale. After several trials the first good plot was established in 1953 and these notes have been compiled to assist anyone who is interested in growing the crop.

The seed is very hard and it is necessary to treat it before sowing in order to obtain good germination. At Sigatoka the Hawaiian method of hot water treatment has been found to be very successful. This consists of raising water to 175°F. taking away the heat source, and adding vaivai seed at the rate of one pound of seed to three and one-third quarts of water. The seed is then left in the water for two and a half hours, and after removal sun-dried. Mechanical scarification would probably be easier but would need special equipment. Some earth from beneath established vaivai trees should be sown with the seed in order to obtain a good stand. A horse maize planter is used and sun-dried earth sown with the seed using the fertilizer hopper on the drill. The seed rate is 20 pounds per acre sown in drills 2 inches deep and 3 feet apart. Frequent intercultivation is necessary in the early stages of growth, as vaivai grows so slowly. It has been found by experience that it is best to sow it in the middle of the dry season when weed competition is low, as in the wet season quick growing weeds and grasses completely smother the slow growing vaivai. It will also grow well on very steep slopes and on thin eroded soils and an attempt to establish it on the hills at Sigatoka is now being made, planting by hand in drills along the contour, and mixing a little soil from beneath established vaivai trees in with the seed. Further information on the culture or feeding value of vaivai can be obtained from the Animal Husbandry Officer, Sigatoka or from the Director of Agriculture, Suva.

—W.J.A.P.

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CROP PROTECTION . . .

BIRDS AS PESTS IN FIJI

By B. E. V. PARHAM

Farmers and gardeners throughout the Colony frequently find cause for complaint in the damage to crops caused by birds: and various control methods have been tried locally over the years without much success. The Department of Agriculture has given attention to control of birds in rice crops, but there is much yet to be done to protect grain, fruit and vegetable crops.

1. GENERAL NOTES

In New Zealand the general conclusion has been recorded [2] that "for all species of birds, loss is at times considerable to particular crops in certain places, but the effect on total production is negligible." Observations over several years suggest that a similar conclusion might well be reached for Fiji.

Martin [1] states there are 168 named species of birds in Fiji; 117 being land birds 39 sea and shore birds and 10 introduced species. Seven indigenous and five introduced species have been cited from time to time as troublesome pests of agriculture. It is, however, not a simple matter to assess to what extent any birds deserve to be called noxious—many of those that take some toll on grain and fruit crops are also largely insectivorous and in this way more useful than harmful.

The recent discovery of the European starling in Fiji [3] has caused concern in some quarters. Overseas the best informed opinion is that this bird exerts a useful control on certain insect pests although it does attack stone fruit crops in season. It is, of course, also regarded as a nuisance in towns and built-up areas. It cannot, however, be disputed that its further spread in the Colony should be prevented and steps have already been taken towards this end.

The species which may for one reason or another be regarded as troublesome are listed in Table I.

BIRDS REPORTED AS PESTS OF CROPS IN FIJI

Common Name	*Sc. Name*	*Distribution*	*Remarks*
Introduced Species—			
Bulbul	*Pycnonotus cafer*	India—common throughout Fiji. Introduced c. 1903	Destroys all fruits, flowers of beans, tomatoes, peas.
Java sparrow	*Gymnorhina libicon*	Fiji—common throughout larger islands.	Grain eater—destroys rice.
Malay turtle dove	*Spilopilia chinensis tigrina*		,, ,,
Speckled neck dove	*Streptopalia suratensis*	Australia, common main islands, Fiji.	,, ,,
Strawberry finch	*Stegonopleura cuttata*		
European starling	*Sturnus vulgaris*	Islands of Ono-i-Lau, Vatoa, introduced c. 1930; recorded as pest 1952.	Destroys soft fruits.
Mynah (house)	*Acridotheres tristis*	Common throughout the Colony; introduced between 1890-1900.	Generally a scavenger living near habitations and not attacking garden crops.
,, (field)	*A. ginginianus*		
Indigenous Species—			
Swamp hen (Teri)	*Porphyrio porphyrio*	Subsp. *viliensis* on smaller islands only: formerly common elsewhere. Recorded pest 1952.	Destroying bananas and root crops at Naiqani, 1953.
Firetail finch (*qiqi*)	*Erythrura cyanovirens*	Common in flocks—a tree finch normally living on flowers and buds.	Occasionally feeds on rice grain in milk stage, grain sorghum, etc.
Kaka or yellow-breasted musk parrot	*Prosopeia personata*	Viti Levu; recorded as pest 1942.	Eats green bananas 1942: *Kauvula* 1953.
Kingfisher (*Lesi, sese*)	*Halycon sancta*	Throughout Colony	Attacks young chickens at Lau 1953.
Chili pigeon	*Columba vitiensis*	,,	Occasionally eats tapioca shoots, 1938.
Goshawk (lge. swamp harrier) *manu-levu*	*Circus approximans*	,,	Slow on wing not very dangerous to poultry.
Sparrow hawk (*Reba*)	*Accipiter rufitorques*	,,	Quick on wing—dangerous to young chicks.

2. DAMAGE TO FOOD CROPS CAUSED BY THE SWAMPHEN (*Porphyrio porphyrio* sub. sp. *vitiensis* Peale)

Late in 1952, the District Commissioner Southern reported that the people of Naigani Island had complained about excessive damage to foodcrops by the native swamphen or Teri. The island is about nine miles off the east coast of Viti Levu and is part of a proclaimed bird sanctuary [3]— During the writer's visit to the island, the Fijians at Navitilevu koro (Plate 1) stated that the birds had increased very much since annual burning off has been prohibited. They described the damage caused by the birds as follows:

Bananas and Plantains—Fruit is eaten when still green and usually the bunches are completely destroyed (Plate 2). Young suckers are eaten down into the ground, and during dry weather the stems of larger plants are attacked and destroyed.

Tapioca—Any roots near the surface of the ground are eaten and often young plants are pulled out of the ground and destroyed.

Yams and Kumalas are also eaten.

Dalo—Mature rhizomes are completely eaten down into the ground leaving only the leafy top and the shell of the rhizome.

Field observations—In the course of a tour of plantations and gardens both flat and hillside plantings of bananas, plantains, dalo, tapioca and kumalas were traversed, but only the fruits of bananas and plantains were seen to be affected. This damage was very heavy indeed, in many cases not a single fruit being left on the bunch attacked. Probably 80 per cent of the bunches seen had been eaten by the birds. Sheets of tin (parts of biscuit tins) are locally used as a protective shield. This is fastened on the top of the bunch and seems to give very good results. (Plate 3).

Bananas and Vudi grow exceptionally well on the island and some very good fruit was seen.

The diseases " leaf spot " and " bunchy top " occur, also the scab moth was seen on one or two bunches on a hillside plot. These latter were the exception as although no dusting is practised the majority of bunches were quite clean and free from " scab." Plantations were not well tended and stools of great age were said to be still producing. Some recent plantings were seen. No fruit is packed for export; all that is grown and left by the Teri is used for home consumption.

The Fijians who acted as guides could not show any evidence of damage to root crops; and much tapioca in excellent condition was seen. The dalo was said to be too immature for attack by the birds.

Description and habits of the Teri—This bird, commonly known as purple gallinule or swamphen is a very handsome species of land rail, native of Fiji, New Caledonia, New Zealand and Australia. In Fiji, Teri were formerly common but are now extinct on the larger islands, but still occur on Naigani, Viwa, Gau and Kadavu. They were reported from Taveuni by Wood in 1923 and have recently been seen in the vicinity of the Rest House at Waiyevo on that island.

At Naiqani the birds are common. At 11 a.m. there were several near the village. They flew from a clump of bananas and took cover in a " vuci " or swamp densely covered with *Acrostichum* fern (*Boreti*) and sedge. They feed at early morning and late afternoon when, according to the Fijians, they enter the outskirts of the village. They nest in dense thickets of reed grass (*Gasau*) on the hillsides (Plate 4) and also in the coastal fern and sedge swamps. The nests are built on the ground or placed on low branches—three eggs are usually laid and the young run immediately after hatching. The local breeding time is during the period January to March when the reed grass is in flower. The birds are well known for their sagacity and also for their " bizarre ideas on gardening." [4] They normally spend most of their time on the ground; vegetable substances form the principal food, but they also eat snails, insect larvae and worms. They often dig out and eat root crops and, in New Zealand, destroy grain in some districts. When disturbed they can fly well but the flight is laboured and awkward. The habits of this bird render it an easy prey to mongoose; and the burning of the vegetation, especially when the young birds are about, destroys many birds.

Size and colouration vary geographically and a number of sub-species have been described.[5]

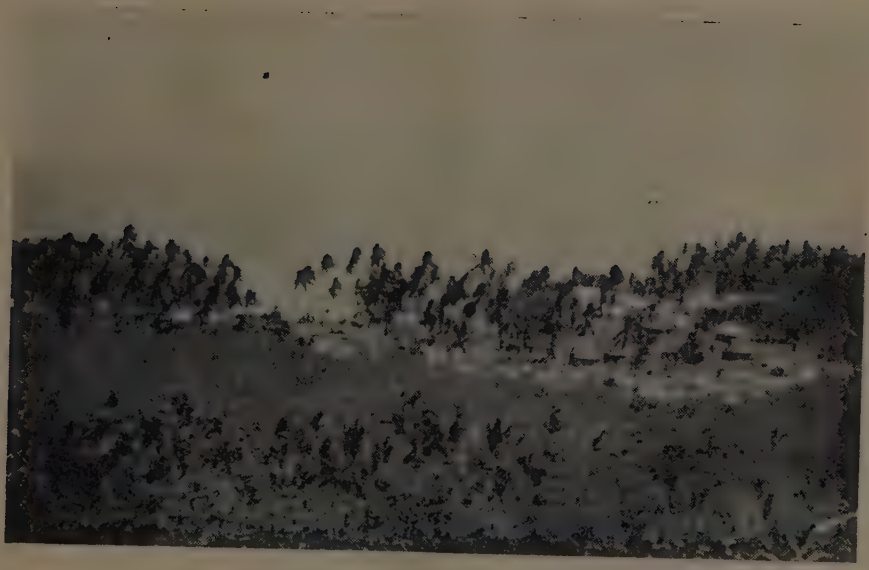

Plate 1.—Navitilevu Koro, Naigani Island, 1952. *Photo B.E.V.P.*

Plate 2.—Banana fruits damaged by " Teri " (" Poryphyrio poryphyrio "), Naigani Island.

Status as a pest—In Fiji, the purple swamphen is protected under the Birds and Games Ordinance (3, Schedule 1): in New Zealand and other countries it is also protected by law. It is one of the few native birds which readily increases when protected and it is generally regarded as a most graceful and handsome animal whose depredations do not justify severe measures of control.

Plate 3.—Banana bunch protected from "teri" by sheet of tin, Naigani.

At Naigani it is certainly doing much damage to bananas but it is possible that, this is partly due to the "laissez faire" attitude of the Fijians who admitted that, with the exception of three men, they were still cropping the bananas planted by their fathers. The banana plots are not well tended and extensive thickets of fern and sedge near-by could well be cleared, so removing shelter and breeding grounds. Part of this very extensive flat is bounded by a stone wall built in former times to protect dalo beds from pigs. The whole of this flat was formerly used for dalo culture but the destruction of a sea-wall in a storm resulted in salt water intrusion which has gradually extended. It appears likely that this area could again be cultivated and both food

gardens and banana plots weeded and cleared of much undergrowth which gives the birds shelter and confidence.

Control Methods—Control of the birds can obviously be achieved by (1) mongoose, (2) burning, (3) shooting and (4) poison baits.

(1) The introduction of mongoose is not wanted by the Fijians themselves; they have refused to consider this before and are quite definite about it. This measure is too severe—it would result in the extermination of *teri*, of other native birds including the very rare *Bici* (*Rallus philippensis*) and of domestic poultry. It would not itself be controlled later unless only one sex were introduced to the island.

(2) Burning off is favoured by the Fijians and is probably the traditional means of controlling the numbers of the birds. At the time of the visit quite an extensive area of hill land had only recently been burned off: it was said this was accidental as a fire on land being prepared for yams spread beyond control. Actually, controlled burning may well be a solution of the problem.

(3) The gun is a ready means of reducing numbers. There are obvious difficulties but it seems likely that one or two shot guns used by approved wardens only on birds in food gardens would help to reduce the numbers and perhaps frighten the birds away.

(4) Poison baits would be difficult to arrange and are probably too dangerous to human life to be seriously considered.

A further possibility arises from the fact that the *Teri* does not frequent forested areas. It might be possible to plant trees in strategic belts on the hills so as to remove nearby breeding grounds.

Protection of Crops—The Fijians have found one quite effective means of protecting banana and plantain bunches. The sheets of tin are inexpensive and can be used several times. They should be a little larger than many seen (Plate 3).

Agricultural Assistant Southern (Uraia Koroi) reports an interesting method used by the Fijians of Colo-i-Suva to protect bananas from the ravages of another bird, the Viti Levu parrot or *Kaka* (*Prosopeia personata*). They use an empty bottle wrapped in banana leaves which is fastened on the top of the bunch with the mouth so oriented to the prevailing wind that a whistling noise is produced. It is said that this noise scares the *Kaka*; but it may not have the same effect on the *Teri*.

A third possibility arises from recent correspondence with the Australian branch of I.C.I. Ltd. who have been investigating the use of plastic bags for covering banana bunches. It has been found that the use of these bags, especially during the cool months, results in a much better quality fruit: and it is possible that they could give adequate protection from birds.

Consideration might also be desirable of the establishment of suitable sanctuaries for these birds in places where they would not be a nuisance.

3. EUROPEAN STARLINGS IN FIJI

Since the discovery in 1951 of the European starling (*Sturnus vulgaris*) in the southern-most islands of the Lau Group as reported by the Reverend W. Hill,[6] the following official action has been taken in collaboration with the Council of the Fiji Society.

Dr. P. E. C. Manson-Bahr during the course of a medical inspection tour spent three days at Ono-i-Lau and reported his observations to the Fiji Society.[7]

The identification of specimens having been confirmed by reference to the Australian Museum, the Government of Fiji arranged for a visit to Fiji by Dr. Robert Carrick, Principal Research Officer of the Wildlife Survey Section, C.S.I.R.O., Canberra, Australia. Dr. and Mrs. Carrick arrived in Suva on the morning of 20th August, 1953, and in company with Mr. C. Walker of the Department of Agriculture were taken direct to Ono-i-Lau the same day by R.N.Z.A.F. Catalina flying-boat.

Dr. and Mrs. Carrick remained there for twelve days studying the distribution and habits of the birds which have now spread

Photo B.E.V.P.

Plate 4.—Naigani Island. Hillslopes with heavy growth of " gasau " reeds, shelter and nesting ground of " teri ".

to three smaller islands in the area. It is also thought that they have reached the island of Vatoa, 56 miles distant.

On their return to Suva, Dr. Carrick reported his findings to a special meeting of interested persons including members of the Nature Protection Committee of the Fiji Society. Mr. Walker remained on the island until 26th September in order to continue the observations in the hopes that the breeding season would commence. Actually this did not occur until the 25th October when the Buli Ono-i-Lau reported by telegram that eggs were being laid.

A technical report based on the investigations of these observers is to be made.

The Economic Review Committee [8] recommended the appointment of a Vermin Control Officer whose duties would include the control and eradication of animal pests including wild pigs and cattle, rats, mongoose and noxious birds such as the Starlings are now considered to be. On his appointment one of his first duties will be to carry out recommendations made by Dr. Carrick for the control of the Starlings in Lau with a view to preventing their spread to other islands in the Colony.

—B.E.V.P.

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CITRUS CANKER

BY R. B. MORWOOD

Oranges, grapefruit and other citrus trees can be affected with the serious disease Canker. It is found in Asia and has spread to other parts of the world. When it appeared in the United States it was described and found to be caused by the bacterial parasite Xanthomonas citri. The Government concerned ordered the burning of the affected trees and also nearby trees. The disease was eradicated after the destruction of nearly four million trees. It has also been found in, and eradicated from, South Africa, the Northern Territory of Australia and New Zealand. Citrus canker is now present in the East Indies, the Philippine Islands and the Hawaiian Islands as well as in many Asian countries. In 1950 *it was found in Fiji and steps are being taken for its eradication.*

SYMPTOMS

Citrus canker first appears on young leaves as small yellow spots about the size of a pin head usually on the lower surface. These enalrge and develop a small spongy eruption which is at first white then light brown. The spot penetrates the leaf and both surfaces soon present a similar appearance. It is surrounded by a watery or greasy margin with a yellow halo shading off into the normal green of the leaf. Old lesions become brown, corky and hard with a crater-like depression in the centre which can be seen with a hand lens. They vary from $\frac{1}{8}$ inch to about $\frac{3}{8}$ inch across and are raised on both surfaces of the leaf.

Spots similar to those on the leaves appear on both twigs and fruit but the yellow halo is less evident and the crater in the centre more noticeable.

Canker can readily be confused with scab which is a much less serious disease caused by a fungus. At first the spots caused by canker and scab appear very much alike but in scab each spot is raised on one side of the leaf only, the leaf itself is often distorted, the halo is less definite and there is no central crater. To distinguish canker then look for the raised corky eruption on both sides of the leaf, the halo, the absence of distortion of the leaf and (with a hand lens) the central crater.

CONTRIBUTING CONDITIONS

The disease is favoured by warm moist conditions. It spreads in raindrops which touch infected spots then run onto healthy parts. It can be splashed or blown from tree to tree in driving rain or carried on implements or by animals. Spread from one district to another is generally due to planting infected trees or to carrying infected fruit from place to place. The disease can be carried on the hands or clothes after touching an infected tree and moving to a healty one.

In wet districts infected trees of susceptible varieties develop so many spotted leaves and cankered twigs that the trees lose their vigour and cease to be profitable.

VARIETAL SUSCEPTIBILITY

Some types of citrus are more liable to canker than others. Grapefruit are highly susceptible, with limes and most varieties of oranges susceptible. Lemons vary but are usually intermediate in susceptibility. Mandarins show a considerable degree of resistance and kumquats are highly resistant.

CONTROL

Both copper and sulphur sprays are of some benefit in the control of citrus canker. In dry areas regular spraying with Bordeaux mixture will keep the disease reasonably well in check but no known spray is adequate on susceptible varieties in a moist climate. Effective control is only attained by complete eradication of all diseased material by burning. With many plant diseases such complete eradication is virtually impossible but in the case of citrus canker and a few other bacterial diseases, it has been shown in practice that the disease can be eradicated. The process requires careful organization and is expensive but several countries have found that it has proved possible and is economically justified.

POSITION IN FIJI

The Department of Agriculture has made considerable progress in the clearing of the original infected area which extended from

Nausori to Navua. Unfortunately a few small outbreaks have been found outside this area but they are being dealt with as they are located.

The method involves:—

(*a*) survey of infected areas;

(*b*) inspection and marking of trees for removal;

(*c*) eradication of infected trees by digging out and burning. Some closely adjacent trees are also removed;

(*d*) follow-up inspections and destruction of any further infections found.

The aim is to wipe out the disease entirely. With canker present some better varieties of citrus could not be grown in this warm moist climate. Furthermore no export industry can be built up while this disease is here.

The majority of owners of citrus trees have responded well to the need for drastic action. The Department is grateful and trusts that the public will continue to co-operate in the eradication of this menace to the citrus industry, and assist its officers to carry out their duties as expeditiously as possible.

Great care should be taken by the public to stop the spread of canker. Citrus trees should not be taken from an affected area to a clean one and any person planting citrus would be well advised to first consult the Department of Agriculture. Citrus fruit (grapefruit, oranges, lemons, mandarins, limes, etc.) from Suva and nearby districts should not be carried to other areas.

DISCUSSION

The world wide appreciation of the seriousness of citrus canker has induced most countries to impose a quarantine ban on the entry of all citrus from countries affected with the disease. Fiji imposes this ban and it requires strict enforcement to see that there are no more introductions of the disease while measures are being taken to stamp it out. The quarantine laws of other countries, particularly New Zealand, rightly prevent the entry of any citrus fruit from Fiji while canker is present in this country.

—R.B.M.

CORRIGENDA

Attention of readers is drawn to the following omissions and errors in Volume 24, Numbers 3 and 4 of December, 1953.

Page 57, column 1, line 9, insert after the word 'export' the words "to New Zealand".

Page 95, column 1, line 10, for "*Ochidearum*" read "*orchidearum*".

Page 100, column 1, line 5, for "283,000" read "383,000".

ENTOMOLOGY . . .

JANUARY TO MARCH, 1954

BY B. A. O'CONNOR

1. *Rhinoceros Beetle*—The known infested area now includes that portion of the south-eastern corner of Viti Levu bounded by a line drawn from Dakuinuku, near Lodoni on the eastern coast, to Korovisilou, near Serua, on the southern coast. Collections of grubs and adults have considerably increased during the quarter, figures being 55 eggs, 970 grubs, 12 pupae and 103 adults (60 male, 43 female). Collections to the end of 1953 had totalled 184 eggs, 971 grubs, 77 pupae and 214 adults (126 male, 88 female). Of the quarter's total 897 grubs and 27 adults (21 male, 6 female) were found in the Veisari–Waiqanaki–Garnett's mill area, and 58 adults (29 male 29 female) in the Lami–Wailoku–Tamavua–Samabula–Cemetery area.

Apart from collection of all stages of the beetle and destruction of breeding places, the main control measures employed are treatment of palm crown with BHC-sawdust mixture and provision of compost traps treated with BHC. These methods have been employed to a greatly increased extent during February and March. During March, 470 compost traps were constructed and the crowns of an estimated 1,500 palms were treated. Cage experiments have shown that a high mortality of bettles can be caused by the crown treatment.

During February, 2,000 predatory *Histerid* beetles of the genus *Leionota* were received from Trinidad by courtesy of Mr. N. L. H. Krauss, and liberated at Bilo and at Garnett's mill.

2. *Fruitfly parasites*—As no field recoveries had been made of the parasitic species *Opius oophilus* and *Opius vandenboschi* which had been imported from Hawaii in 1951, a request was made to the Hawaiian Board of Agriculture and Forestry for further consignments of parasites. As a result the following liberations were made in the field during March:

Opius oophilus: 90 males and 350 females at Vunidilo, 226 males and 262 females at Nasinu.

Opius longicaudatus (3 sub-species) 316 males and 252 females at Dravuni, 125 males and 33 females at Nasinu.

Opius longicaudatus breeds readily on the local fruitfly *Dacus passiflorae,* and is at present being bred in the laboratory. One specimen of *Opius oophilus,* the species which it is most desired to establish, has bred out from *Dacus passiflorae.* There is some confusion as to whether this was bred in the laboratory or from cherry guavas collected at Vunidilo on March 3. If the latter is the case, and it seems likely, it would show that *O. oophilus* is established in the field. Breeding of *O. oophilus* in the insectary is very difficult, and cannot at present be undertaken.

3. *Coconut Stick Insect*—A parasite of the eggs of *Graeffea crouani* has been found to occur in Fiji. It belongs to the *Hymenopterous* family *Eupelmidae,* and is considered by the Commonweath Institute of Entomology to be probably a new genus. The average number of parasites emerging from eight eggs collected at Savusavu was 12 (2 male, 10 female). Indications are that the developmental period from egg to adult is five or six weeks. The parasite occurs also on Taveuni, and probably throughout Fiji, as it is apparently an endemic species. The occurrences of this parasite may help to explain the rise and fall of populations of the stick insect. Further investigations on the life-history and habits of the wasp are to be made as soon as possible.

4. *Biological control of Lantana*—Importation from Hawaii of the leaf-rolling moth, *Blepharomastix acutangulalis,* has been delayed by difficulties in supplying *Premna* cuttings for feeding trials. An attempt is to be made to send twigs of *Premna* in vials containing water, if quarantine regulations in Hawaii do not preclude this. The Hawaiian authorities have been requested to forward colonies of the moth without waiting for feeding trials on *Premna* if delay in conducting these would jeopardize the chance of establishing the insect. The

feeding trials could then be carried out in Fiji. Several other promising species of insects which are being bred in Hawaii have not yet been certified safe for distribution.

5. *Biological Control of Noogoora Burr*—Thousand of burrs which were collected near the site of liberation of the seedfly, *Euaresta aequalis*, have been dissected, but no evidence of the presence of the insect has been found.

6. *Miscellaneous*—The treatment of timbers on Suva wharf by dusting with Paris Green to exterminate the termite *Coptotermes acinaciforius* has been reported to have met with considerable success, though the pest has probably not yet been completely eliminated. Workers on the wharf state that timbers removed during the last six months or more have been free from termites.

Reports from the Gilbert and Ellice Islands state that the ladybird *Rodolia cardinalis*, which was sent from Fiji to control a severe outbreak of the giant mealybug *Icerya aegyptiaca*, has been successful in reducing the infestation.

ECONOMIC BOTANY . . .

HISTORY OF SOME RICE VARIETIES IN FIJI

BY R. BADLU

Until about fifty years ago, no rice was grown in Fiji. Clean milled rice was imported from other countries for the Indians who had come to Fiji under the indenture system. The story of rice growing in Fiji begins in the year 1902. *Mrs. Lalta Singh, while preparing rice for cooking, found some padi (or unmilled rice) in it. She began picking it out of the rice. She picked it out carefully, and filled a Capstan tobacco tin with the padi. She had no idea as to the country that the rice came from.*

In the same year, she and her husband moved from Ulaicalia to Nakadi (Toli) as their agreement was completed. The couple prepared a small piece of land in order to plant the precious seeds which they had very carefully preserved. The seed grew and the plants ripened and gave about two pounds of padi seed. The couple were very proud and planted the seeds again next year. This time they harvested a kerosene tin full of padi. Zeal and happiness were immeasurable when they asked the overseer and were allowed to have a piece of ground, where with the overseer's help they were able to plant the tinful of padi in 1904. The rice plants grew satisfactorily, and the growing green leaves increased their happiness. Their neighbours on Naitasiri estate came to see the plants and admired the rice field. One Madrasi man said that the rice was no different to that grown in Patna, so people began to call it Patna rice.

In the year 1905 a man named Bhikhari took a tin of padi from Lalta Singh and took it to Koroqaqa, in Naitasiri. He later gave seed to other growers, including Mohabet of Vuci in Rewa. This man had obtained a 10-acre native lease at Kuku after his period of indenture was completed, and he grew his padi there, and later on gave seed to his neighbours round Nausori. In 1916 a Chinaman had given a handful of padi to an Indian named Baignath of Vuci. Baignath had also obtained some padi from Mohabet, and he grew the two side by side. To his surprise he found that he harvested Mohabet's rice in May and the Chinaman's in June. Since Mahabet's rice came from Rewa, he called it *Rewa Patna*, and he called the Chinaman's rice *China Patna*. These varieties have been important in Rewa since 1920, where the same names are used; but when China Patna was taken to Sigatoka, it became called Lakarawa which means " hard as wood ".

It is said that the varieties *Motmuria*, *Sareya Patna*, *Karia*, and *Golka* were introduced to Fiji by people who went back to India when the Navua sugar mill was closed and their agreement completed, and who later returned to Fiji.

The New Guinea variety was introduced from the island of New Guinea. In 1923 a man named Chipan went to the Government Station at Port Moresby and worked in the rice there under Mr. Maxwell. He planted some varieties which had just been introduced to Papua that year probably from Burma. In 1924 Chipan returned to Fiji and brought back with him two-ounce samples of each of five varieties. He planted them on his own land at Naitonitoni, Navua, but only one of the five varieties grew, so he called it simple " New Guinea ". He increased the seed each year and gave some to his friends. Soon they found that they could grow two crops of the variety in a year. Chipan has moved to Vunikavikaloa, in Ra, and there, in April 1952, he told me this story of the introduction of *New Guinea*.

BATIKI BLUE GRASS IN TRINIDAD

A recent Trinidad article by J. R. Howes[1] refers to a taint in cow's milk caused by grazing of *Ischaemum aristatum* L., the grass known in Fiji as *Batiki* blue grass. The author describes the taint noticed in October 1952 in milk from the dairy at the Imperial College of Tropical Agriculture Trinidad as a " pronounced odour of garlic " and states that it is more pronounced when the grass was fed in the flowering stage. He concludes that it is " unwise to contemplate any further plantings of the Trinidad strain of the grass for dairy cattle—but that existing pastures should be utilized only by beef and dry or growing dairy stock. He suggests that for grazing purposes in wet tropical areas of the West Indies the closely related species (*Ischaemum timorense* (Kunth) C. E. Hubbard)—be used as an alternative. This grass is known in Fiji as *Waidoi* grass and does not compare locally in productivity or palatability with Batiki blue grass. He speculates on the fact that this " milk taint has not been reported from areas such as Bombay and Fiji where the grass has existed in pastures for several years ". The grass is now widely established in dairy and beef cattle pastures in Fiji—but to date no such effect has been noticed. Consequently local readers are invited to write in and record their observations on this point.

REFERENCE:

1. Howes, J. R. 1953—"A Taint in Cow's Milk caused by the grazing of *Ischaemum aristatum* L."—Top. Agric. Vol. XXX, Nos. 10–12, 224–7.

TOBACCO WEED—TOVAKO NI VEIKAU (ELEPHANTOPUS MOLLIS H.B.K.)

Tobacco Weed (Elephantopus mollis H.B.K.) is a declared secondary noxious weed on the island of Viti Levu, and a primary noxious weed throughout the other islands of the group, excluding the Labasa district, Vanua Levu. The species is a pest of pastoral, agricultural and plantation lands.

DESCRIPTION

Tobacco Weed is an annual, usually green in colour, and rosette in its early development, growing with an erect stem up to three feet tall, which branches to carry a number of flower heads. The leaves are serrated, elongated and pointed. Fine hairs cover the whole plant. The prolific seeding and rosette development of the young plants produce a thick cover over the ground which tends to smother the grasses. These attributes together with the fact that it is useless as a fodder make it a plant without a redeeming feature, and it should be destroyed wherever located.

Botanical Description:—

Elephantopus mollis H.B. & K.
Family: Compositae.
Common Names: Tobacco Weed, Tavako ni veikau, Elephant's Foot.

An erect herbaceous plant, 2 to 3 feet (70 to 105 cm.) high. Stem stout and tomentose. Leaves cauline, oblong or oblongovate, narrowed into the short petiole blade with serrated edges, softly tomentose on the lower surface, rough on the upper surface, 3 to 6 inches (7·5 to 15 cm.) long and 1 to 2 inches (2·5 to 5 cm.) wide, midribs and veins more pronounced on lower blue green surface. Glomerules many headed, the subtending bracts usually shorter than the glomerule, sessile, mucronate, serrulate or almost entire, nerves pronounced on both sides. Heads four-flowered. Involucre cylindrical, of few lanceolate scales, inner ¼ inch (7 mm.) long, outer scales shorter.

Corolla white, about ¼ inch (7 mm.) long. Fruit is an achene, narrowed below, ten-ribbed with minute hairs between the ribs, 1/16 to ⅛ inch (1·5 to 3 mm.) long. Pappus consists of five straight, rather rough, bristles about ⅛ to 3/16 inch (3 to 4·5 mm.) long.

The seeds of *Elephantopus mollis* are distributed by wind, by becoming attached to the coat of animals or the clothes of man or by being carried in the mud on the feet of animals.

Elephantus mollis was first described by Humboldt, Bonpland and Kunth in " Nova Genera et Species " in 1820. The specimen originally described was from tropical America where most of the twenty species of *Elephantopus* are found. It is not known when it was first introduced to Fiji.

CONTROL

In its early stages of growth, or during regrowth following cutting, it is readily susceptible to hormone types of weed killers. The following have been found to give adequate results:—

2,4,D (Dichlorophenoxyacetic acid), Weedone 57 applied at the rate of 1 in 80.

2,4,D = 2,4,5,T. (Trichlorophenoxyacetic acid), Weedone Brushkiller 32, applied at the rate of 1 in 160.

2,4,5,T. (Trichlorophenoxyacetic acid), Weedone Special, applied at the rate of 1 in 160.

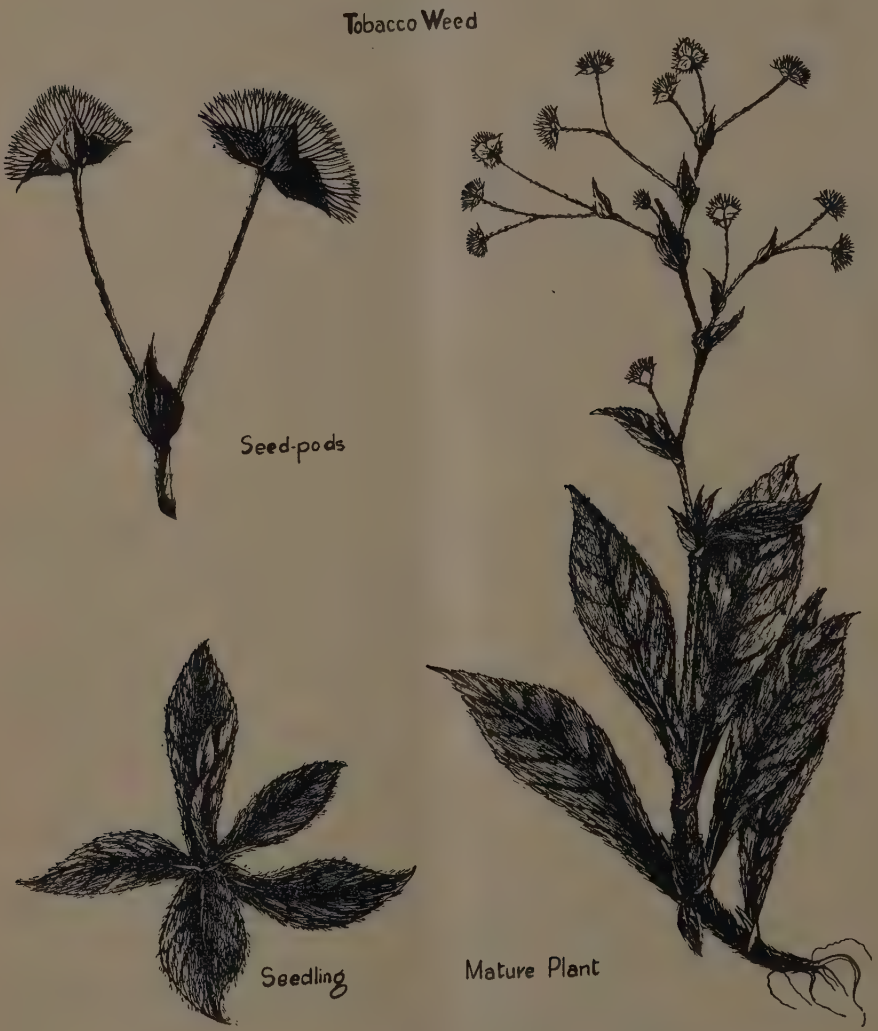
M.C.P. (2 methyl 4 chlorophenoxyacetic acid), 5 per cent Agroxone Dust, applied at the rate of 40 lbs. per acre.

Best results have been obtained when the spraying has been carried out during hot, fine weather. It is important that the plant be thoroughly covered, wetting all growing points. Dusts are best applied when plants are covered with early morning dew.

—T.L.M. & J.W.P.

REFERENCE:

Fawcett & Rendle.—" Flora of Jamaica " Vol. VII. Part V.



Tobacco weed : Elephantopus mollis ", H.B.K.

TOBACCO WEED CONTROL IN VANUA LEVU

Tobacco weed occurs over a large portion of the Wainunu area of the Bua Province of Vanua Levu and is recognized as a serious plantation weed. Recommendations for its control have been made. In February and November of 1952 the Department of Agriculture Weed Control Officer, carried out two large scale demonstrations in the area. These demonstrations covered an area of 35 acres. Generally speaking, control measures are aimed at destroying the young plants to prevent seeding and to enable the establishment of grass pastures.

The area of 35 acres was almost completely covered with tobacco weed. This was first mowed with Allen motor scythes to remove all mature and dead plants thus allowing the sprays to be applied directly to the seedlings.

Three herbicides were used.

(*a*) A mixture of 3 lb 2, 4–5, T. plus 6 lb 2, 4–D. was applied to 14 acres at the rate of 1 in 80. (That is 1 gallon of mixture to 80 gallons of water.) This treatment gave a satisfactory measure of control.

(*b*) Six lb 2, 4–5, T. plus 1 lb 2, 4–D. was applied to six acres at a rate of 1 in 80. The results obtained were satisfactory but not sufficiently superior to warrant the cost of the stronger mixture.

(*c*) Dust containing 5 per cent M.C.P.A. was applied to 4 acres at a rate of 60 lb per acre. The action of this chemical was a little slower than those used in (*a*) and (*b*) but the results were equally satisfactory. The dust appears to be more difficult to apply and is carried more readily by the wind.

Recently the Weed Control Officer completed a tour of inspection and survey of the known tobacco weed areas of Vanua Levu. At Wainunu Estate there has been considerable effort in an attempt to control the weed. During the 12 months ending November 1953 work has been concentrated on the area where the Weed Control Unit demonstrated in 1952. This has been extended to approximately 80 acres. Use had not been made of the small seed bed of Batiki blue grass, planted by the Weed Control Unit for use as ground cover in freshly cleared areas. This is unfortunate as it is essential that the place of the weed should be taken by useful pasture grasses or crops.

Unfortunately the effort made by other landholders has been very small.

The seed beds of Batiki blue grass planted in Wainunu area clearly show that this grass is suitable for the district and superior to the present grasses and if encouraged would readily become established.

Mowing and spraying with hormone herbicides, the establishment of good pasture grasses and an adequate effort on the part of the landholders indicate that a satisfactory control of tobacco weed could be obtained.

—T.L.M.

CACAO AT NADURULOULOU, 1953

Progress during 1953 has been concerned mainly with the establishment of additional selected cacao plants to be used for propagation purposes, with routine trials and studies of methods and techniques and with the recording of growth and yield performance of individual trees now growing at Naduruloulou. The following notes of the report therefore provides a statement of progress made to date with this work and of prospects for further developments with special attention to the availability of suitable propagation material, the capacity of existing and planned facilities and the production of seedlings for distribution.

The material available on the station in January 1954 comprised a total of 2,448 plants and included the following:—

(*a*) Trees planted out in the field of which 24 are now in bearing 418

(*b*) Cuttings in nursery (20 strains) 110

(*c*) Seedlings in nursery 1,920

Strains include—

(*a*) Lafi No. 7—40 seedlings, a few now flowering (Plate 3), from Samoa.

(*b*) I.C.S. 1—4 trees, 1 flowering (Plate 2) from Trinidad.

(*c*) Forastero, Amelonado, local
1 tree (bearing)
28 seedling trees, (Plate 4).
from Papua-New Guinea.
37 cuttings rooted.

(*d*) K 4, 5, and 10—5 cuttings established.

(*e*) KA 2—102; 20 seedlings established.

(*f*) K 26, 6; 18 seedlings established.
from Trinidad.

(*g*) ICTA selection (12 strains)—19 rooted cuttings local: established.

(*h*) Forastero x Criollo—20 trees.

(*i*) Criollo (predominantly) 4 trees.

Facilities at the Station include:—

(*a*) Battery of 8 propagating bins (Trinidad type) capacity 2,000 rooted cuttings per annum (Plate 3).

(*b*) Six Keravat propagating boxes, capacity 400 rooted cuttings per annum.

Construction has commenced of three more of the larger (Trinidad) propagators and 20 Keravat boxes which will give a total annual capacity of approximately 15,000 rooted cuttings sufficient to plant 70 acres.

Plate 1.—Young cacao tree—variety " Lafi " No. 7, grown from seed supplied by N.Z. Reparations Estates, Western Samoa (F.D.A. No. 13182). These trees have commenced to flower at 25 months of age.

Seedling production for 1954 is estimated at 10,000—giving a total potential supply of 25,000 plants during the next 12 months. Allowing for losses during transplanting this may be taken to represent sufficient material to plant 100 acres.

Extension Work—A trial planting at Naqeledamu has been established in co-operation with Savenaca Tavusovuso. The site is capable of extension—300 seedling "Amelonado" planted in February, 1953 are growing well (plate 5). Arrangements have now been completed for the planting of over 1,600 seedlings at three separate localities in SE Viti Levu—suitable areas are being listed.

Plate 2.—"Trinitario" cacao—I.C.S.I., introduced from Trinidad via Kew, June, 1950. (F.D.A. No. 13003), with first crop maturing September, 1953. Note fan growth of main branches.

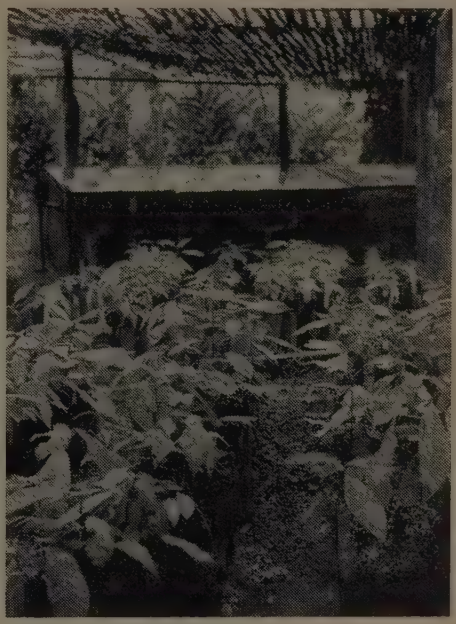


Plate 3.—Cacao seedlings at Naduruloulou. The Trinidad type propagator in the background has been used successfully for the propagation of rooted cuttings of several of the selected comes at the station.

Advisory Work—Much interest has been shown by Fijians and Europeans in the prospects of cacao planting—and a great deal of information has been given. Many visits have been arranged to enable people to discuss the work on the spot.

Plates 1 to 4 by R. R. Wright.

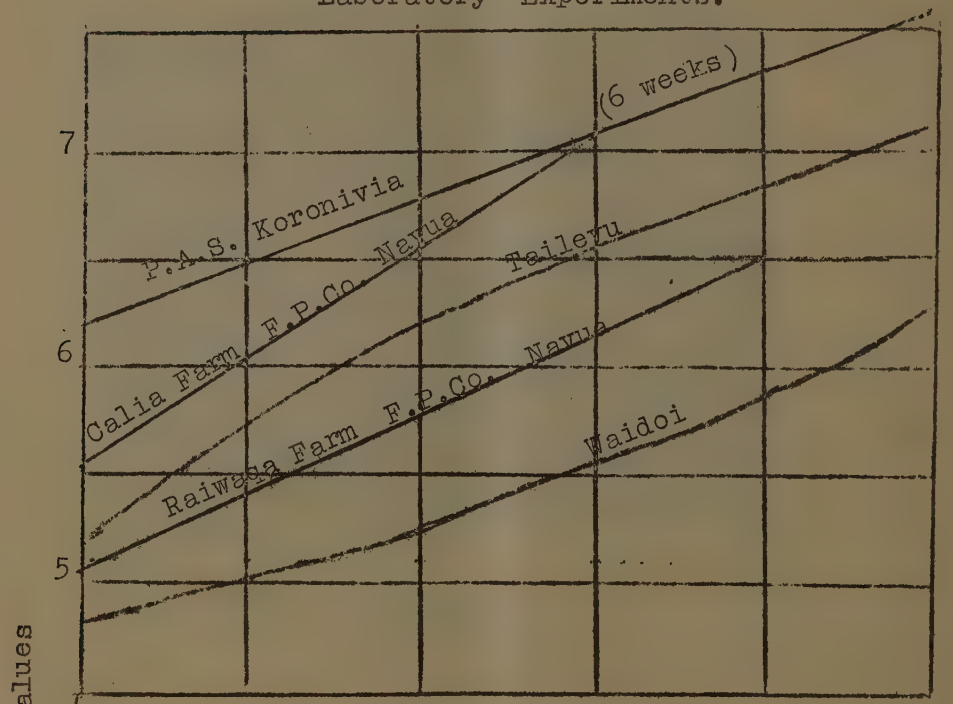
—B.E.V.P.

Plate 4.—A hedge of young cacao at Naduruloulou. The variety is "Forastero-amelonado"—these plants are seedlings from tree R4T3A. They have commenced to flower at 24 months. From these, cuttings will be taken for propagations.

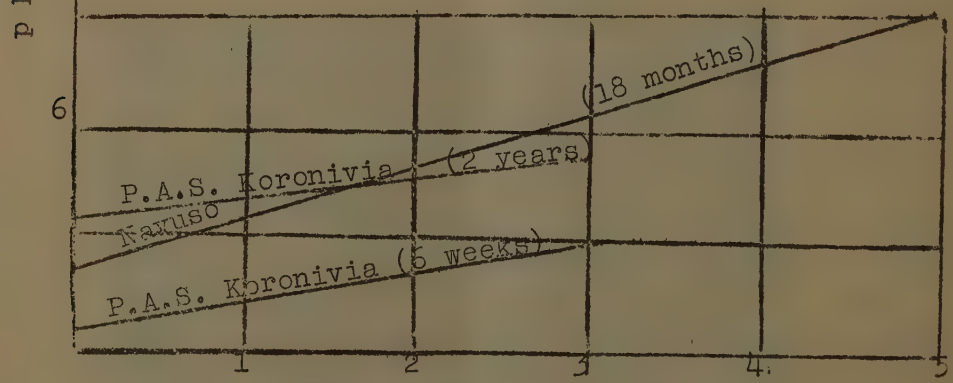
Plate 5.—Fijian cacao plantation at Naqeledamu. Party arrives to begin planting 300 seedlings of "Amelonado" type, February, 1953.

LIMING OF ALLUVIAL SOILS

Laboratory Experiments.



FIELD TRIALS



pH Values

CHEMISTRY . . .

THE USE OF LIME ON FIJI SOILS

BY N. G. CASSIDY

In a previous article[1] *the results of liming trials in the island of Viti Levu were reviewed whilst a further note*[2] *dealt with available sources of limestone and its quality. The present paper sets out further information on two points, namely, the time that coral sand takes to react completely with the soil, and the lime requirement of Fiji soils. It also mentions recent developments overseas.*

THE FATE OF CORAL SAND IN THE SOIL

This investigation was made on the alluvial soil of the Principal Agricultural Station, Koronivia. The plots had been laid out for an experiment which was however, finally abandoned, and it was felt that useful information could be obtained by investigating what had happened to the coral sand applied in the limed plots.

With this object in view three plots were selected from the old experimental site as shown below:

Plot 1 (Control)—No lime applied.
Plot 2 (N.P.K.)—No lime applied.
Plot 3 (L.N.P.K.)—Lime at 3 tons p.a.

Soil samples were taken from these plots at two depths, (0–9″) and (9–24″) respectively, two years after the application of lime. The samples were sieved through a 2 mm. sieve and air-dried in the usual way. Determinations were then made for carbonate content and for pH. The following table shows the pH values obtained, with the true means shown in brackets.

pH VALUES

Depth	*Plot 1* (*No lime*)	*Plot 2* (*No lime*)	*Plot 3* (*Lime at 3 t. p. a.*)
	5·6	5·6	5·7
	5·6	5·6	5·9
(0–9″)	5·6 (5·62)	5·6 (5·62)	5·9 (5·89)
	5·7	5·7	6·2
	5·6	5·6	5·7
	5·7	5·7	5·8
(9–24″)	5·7 (5·70)	5·7 (5.70)	5·8 (5·78)
	5·8	5·8	5·8

pH VALUES

All samples showed a negligible amount (0·003 per cent) of calcium carbonate, there being no apparent difference between the treatments or between surface and sub-soil. As three tons per acre of coral sand is equivalent to about 0·3 per cent of calcium carbonate in the surface 9s of soil, it appears that the applied lime has been totally decomposed or dispersed in the two years which had elapsed after application.

The agreement between Plots 1 and 2 in the above table is remarkably good. Plot 3 shows a definite and significant difference in pH value from the "No lime" plots as regards the surface soil; the difference is negligible in the case of the sub-soil.

Although no determination was made of the fineness of the coral sand used, it may be said that the median value for particle size was approximately 1 mm.

Since there was no opportunity of sampling the soil at the beginning when the coral sand could be expected to be having its maximum effect, there is no indication of how much higher the pH value may have been. The present study was therefore concerned merely with the persistence of coral sand in the soil. It can be said that under the prevailing conditions of high temperature and a 130-inch rainfall the life of the coral sand in this alluvial soil was two years.

THE LIME REQUIREMENT OF FIJI SOILS

Some early information on this subject was obtained by W. J. Blackie who has published in the *Agricultural Journal* his results for laboratory determinations using Hutchinson & MacLennan's method, and also for field trials on the liming of test strips. He also examined 115 soils in the Nausori area where he found a mean lime requirement of less than ½ ton per acre. The alluvial soil of the Agricultural Station, Sigatoka*, was found to have no need for

* Classified as Sigatoka clay loam in the New Zealand Soil Bureau's provisional soil map.

lime. All of this work refers to alluvial soils, from Tailevu, Navuso, Rewa, Navua and Waidoi. Most of these are classified in the New Zealand Soil Bureau's provisional soil map of Viti Levu as Navua clay loam—a glayed recent soil.

This information has been extended by the writer with laboratory experiments in which two kinds of lime, coral sand and Tau limestone, were each used (at different degrees of fineness) for the liming of two soils (1) the alluvial soil at P.A.S. Koronivia and (2) the red soil developed on soapstone at Samabula. Liming materials of the following fineness were used:

FINENESS OF LIMING MATERIALS USED

Coral Sand—		
(Natural)	"Medium"	Medium value 1/40 inch: but 30 per cent of particles larger than 1/15 inch.
	"Fine"*	85 per cent in the range 1/15 to 1/120 inch.
	"Very Fine"	85 per cent less than 1/120 inch.
Limestone—		
	"Fine"	85 per cent in the range 1/15 to 1/120 inch.
	"Very Fine"	85 per cent less than 1/120 inch.

The liming materials were well mixed with the soils at the rate of 5 tons per acre and throughout the experiment the soils were held at optimum moisture content. Under these conditions a maximum speed of reaction could be expected between soil and lime. It is not intended, of course, that such experiments should simulate what actually happens in the field.

pH values were taken weekly and the final readings were made at the end of six weeks. It was found in all cases that most of the pH change had taken place within the first week and an approach to equilibrium had been attained after six weeks.

The treatments and the final pH values (mean of last three weekly readings) are shown in the table of the Appendix.

RESULTS

In every instance a finer grade of lime gave a higher pH value. There was no appreciable difference between coral sand and limestone of the same degree of fineness, sometimes one and sometimes the other appearing to be the more effective. In each case five tons per acre of very fine lime was sufficient to raise the pH of the Samabula soil from 5·3 to 7·3 within the six-week period of the experiment, although, under these conditions of adequate moisture and perfect mixing most of the rise in pH had already occurred within the first week.

These results with different degrees of fineness help to confirm experience in other countries that a considerable portion of a limestone sample should be less than about 1/40 inch in size if it is to be of much immediate use in the current growing season.

The data are shown in the Appendix with graphs for both laboratory determinations and field trials.

The greatest slope of the curves for laboratory determinationa as against field trials indicates a faster action resulting from the more perfect conditions of moisture and mixing. This means that laboratory estimates will be inclined to be too low but will at least guard against the danger of over-liming. On the basis of these curves a short guide to liming has been drawn up, so that for a soil of known pH the probable value after liming can be found.

GUIDE TO LIMING.

Initial	*Probable pH value after liming*				
pH value	1 *t. p. a.*	2 *t. p. a.*	3 *t. p. a.*	4 *t. p. a.*	5 *t. p. a.*
5·0	5·4	5·7	6·1	6·6*	7·0*
5·5	5·8	6·2	6·6*	7·0*	
6·0	6·4	6·8*			

THE CASE OF TROPICAL RED EARTHS

These soils have a different constitution from siliceous soils and do not respond to liming in the same way. Middleburg[4] working with recent volcanic ash soils in Java and Sumatra has even concluded that any liming of tropical red earths is to be avoided. The red earths of Fiji are sedentary soils on basaltic or andesitic tuff and are not at all closely related to the volcanic ash soils of Java. It is therefore necessary to test the response of our own soils to lime. Much of the hilly land in Tailevu and elsewhere has shown promise with observational lime trials and this should be systematically confirmed now that the soil types have been delineated by the soil survey.

NOTE.—These figures apply to alluvial soils.

* Liming is not recommended.

* The "Fine" coral sand was slightly more coarse than the "Fine" limestone having the same overall range of particle size.

SIZE OF CORAL SAND

Recent practice in Fiji has tended towards the use of coral sand of such large size that much of it would have no appreciable affect on the soil within several seasons after it had been applied. It is essential to have an evaluation of the relative effect of various particle sizes, and this is being pursued. After an estimate has been obtained of these relative values it should be possible to decide whether it would be more economic to sieve bulk material down to a moderately effective size or to carry out a more costly grinding process. This will no doubt be influenced by the yield of finer particles to be obtained from the bulk supply by simple sieving.

NEW DEVELOPMENTS

Recent work on sugar cane in Queensland[5] has indicated that as much benefit may be obtained from half a ton of ground limestone drilled into the soil as from two tons per acre broadcast. The experiments were set out at from three to five sites in each of four different cane areas, to find out what benefit is to be derived from liming acid soils. The mean yield quoted is from a plant and one ratoon crop in each case. The following extract illustrates this effect, but it also shows the relatively small increases which were obtained from liming.

Lime applied	*Mean yield and increase (tons per acre)*				
	Mackay	*Cairns*	*Innisfail*	*Bundaberg*	*All*
None (Yield)	21·82	23·06	36·40	36·82	....
2 t. p. a. broadcast (Increase)	1·60	0·58	1·21	0·07	0·86
½ t. p. a. in drill (Increase)	0·94	1·52	1·21	0·40	1·02

The absence of substantial increases due to liming lends support to a view now being put forward, that acid soils are productive provided ample supplies of plant nutrients are present. Acidity, according to this view, is merely an indication that plant foods will have been removed and must be replaced. It is too soon to say whether this view will be substantiated, but more trials should be carried out on our own soils with this hypothesis in mind.

SUMMARY

The effect of coral sand on an alluvial soil two years after the time of application has been investigated.

The available data on the lime requirements of some alluvial soils has been summarized and a guide to liming has been prepared.

The case of tropical red earths, the size of coral sand, and some new developments in liming have been considered.

The need for more knowledge of our own soils and our own conditions has been pointed out.

APPENDIX

EFFECT OF FINENESS OF LIMING MATERIALS ON RATE OF REACTION

Liming treatment	Mean value of final pH	
	Koronivia soil	Samabula soil
None	6·4	5·3
Coral Sand 5 tons per acre—		
" Medium "	7·2	6·6
" Fine "	7·3	7·1
" Very Fine "	7·6	7·4
Limestone 5 tons per acre—		
" Fine "	7·4	6·6
" Very Fine "	7·7	7·3

REFERENCE:

(1) Cassidy, N. G.—Fiji *Agric. Jour.* (1952) 23·5 " Response to lime in Viti Levu ".

(2) Cassidy, N. G.—Fiji *Agric. Jour.* (1952) 2·4 " A reconnaissance survey of liming materials in Viti Levu."

(3) Blackie, W. J., ibid. (1936) 8.5–7
(1937) 8.3–6
(1944) 15.4–7, 3–36

(4) Middleburg, H. A., De Bergcultures (1952) 21. 126–130 " The lime requirement of tropical red earths."

(5) Vallance, L. G. Q'ld. Bur. Sugar Expt. stns. Anl. Rpt. (1953) p. 15.

THE SOILS OF THE NAVUA PLAINS AND THEIR CHEMICAL STATUS

BY J. P. FOX* AND I. T. TWYFORD

During the course of the Reconnaissance Soil Survey of Fiji, the Navua Plains were surveyed between June 15th and June 19th 1953 inclusive. In the absence of aerial photographs, one inch to one mile topographic maps were used.

The Navua Plains lie on the lower Navua River. Navua township, near the centre of the plain, is 26 miles by road west of Suva. The plains extend about 10 miles along the south coast of Viti Levu from Lobau River to Taunovo Bay, They reach their greatest width, five miles, on a line south-east from the Navua Gorge to the sea, and have an area of approximately 20,000 acres.

The Plains are formed of debris and alluvium brought down from the hills by the Navua River. Former islands remain as isolated hills and provide useful refuge in times of flood.

As the Navua Plains are on the south coast of Viti Levu they experience frequent heavy rains and have an annual rainfall of approximately 150 inches.

The former vegetation was tropical rain forest but this has long been cleared for native gardens. Since the arrival of the European, large areas have been established in para grass and rice. Only the very infertile peats and sandy soils support rushes, sedges, ferns and stunted trees.

Recent soils are formed on alluvium which is constantly receiving additions of fresh material or has ceased to receive such additions so recently that the soil forming processes of leaching and weathering have not had time to develop distinct soil horizons. Where the alluvium contains high proportions of silt and clay which readily weather to release plant nutrients, fertile soils are found, but where the proportion of sand is high the material has had little time to weather and few plant nutrients are available. In addition with the rainfall as high as at Navua, permeable, sandy soils are rapidly leached of the few plants nutrients they possess.

Soils in which ground water frequently rises to the surface or lies just below the surface for long periods, develop characteristic properties. The most important of these are the presence of conspicuous red brown iron oxide stains and dark brown concretions of iron and manganese oxides. Such soils are named Gley soils. Gley Recent soils also receive additions of fresh material from floods as they retain some characters of a Recent soil.

The main problem in the utilization of the Gley Recent soils, which are usually fertile, is to control the amount of water in the profile. This usually means removal of excess water by drainage but for rice crops, abundant water is no problem. However, the coarse Tokotoko sandy clays contain so much sand and are so little weathered that they contain a very small reserve of plant foods.

Where conditions are extremely wet and water lies on or above the ground level for long periods, the oxygen in the soil and ground water is used up and plant remains do not completely decompose and gradually accumulate. Shallow lakes and swamps may in time be completely filled by partially decomposed plant remains. This material is called peat, and soils formed from it are called Organic soils because they have developed through the activities of organisms and not from the deposition of mineral matter. The properties of peat vary with the type of vegetation accumulating and with the source of water forming the swamp. If the groundwater is rich in minerals, sedge plants flourish and produce a fertile mellow peat. If the ground water drains impoverished soils and a high proportion is derived directly from rain water, as at Navua, rushes and mosses form the dominant vegetation and produce acid, very infertile peats.

The Navua Plains' soils are formed on alluvium from basalt, andesite, coarse-grained diorite, and gabbro rocks. Field textures range from clay loams to sands and peat. Five soils series were recognized and they may be classified as follows:—

Recent soils:—
Rewa clay loam
Navua clay loam.
Gley Recent soils:—
Tokotoko clay loam
Tokotoko sandy clay loam
Deuba sandy loam and sand.
Organic soils:—
Melimeli peat.

SOIL DESCRIPTIONS

Rewa clay loam is developed on levees along the banks of the Navua River and the small streams draining the adjacent hills. A representative profile is:—

10 ins. brown clay loam; friable; moderate, fine blocky structure; passing over one inch to
26 ins. + reddish brown clay loam; friable; very fine blocky structure.

This soil is free draining and fertile. It is intensively used for dairying, bananas and food crops.

Navua clay loam lies at a lower level than the Rewa clay loam. Surface drainage is impeded because levees prevent water from flowing to the river and streams.

A profile from ½ mile east of the Deuba River is:—

6 ins. brown clay loam; friable; distinct, abundant, fine reddish brown mottles; grading over 2 ins. to
30 ins. + reddish brown fine sandy clay loam; distinct, medium sized reddish brown and light grey mottles; plastic.

Profiles vary with the degree of gleying, and with increased gleying grey colours appear.

Navua clay loam is moderately fertile and is used for dairying and rice production.

Laboratory data are given in the table at the end. The two samples were from 1 mile along Vakabalea Road from Queens Road turnoff and from Wainadoi Valley just outside the area studied.

These data indicate that the Navua clay loams are particularly low in acid soluble phosphate. In the case of the Wainadoi sample, lime is also low. Trials are needed to establish the suitability of dressings of phosphatic manures other than superphosphate which is readily "fixed" by tropical soils and made unavailable to plants. (See section on phosphates.)

Tokotoko clay loam is developed on recent sediments where water tables are near the surface. A profile from the corner of Queen's Road and Tokotoko Road is:—

5 ins. light olive brown clay loam; few small yellowish red mottles along root hairs; plastic; very fine blocky structure.

10 ins. grey clay loam; distinct, many, medium sized yellowish red mottles; plastic, dries out hard.

10 ins. grey clay; plastic; occasional greenish grey mottles; *ON* grey clay; prominent, coarse, reddish yellow mottles; plastic.

Where conditions are very wet, profile colours are greenish or bluish grey; this soil type is fertile and widely devoted to dairying and rice production.

Analytical data are given in the table, the profiles being located:

(1) near the junction of Queen's and Tokotoko Roads and

(2) 2½ miles west of the Navua river on Queen's Road.

The figures indicate that Tokotoko clays are low in phosphate and lime but have an adequate potash figure. Applications of phosphate and ground calcium carbonate should raise rice yields and improve pastures for dairying.

A small area of *Tokotoko sandy clay loam* occurs in the Taunovo valley. These soils have been formed by the deposition of silt and clay on coarser sediments. They are intermediate in properties between the Tokotoko soils and the Deuba soils, being

more liable to suffer from drought than the former, and more fertile than the latter.

A profile is:—

8 ins. dark grey sandy clay loam; plastic; moderate, fine and very fine blocky structure; faint, fine, many yellowish red mottles, particularly along root hairs.

4 ins. dark grey sandy loam; plastic; distinct, many, medium sized yellowish red mottles; grading to

20 ins. + bluish grey sands; non-plastic; slightly sticky.

A larger area of Tokotoko sandy clay loam occurs between Togoru Creek and Melimeli village. The soils here appear to be infertile and support a vegetation of coarse grasses and ferns.

A profile is:

0–15 ins. very dark brown sandy clay loam, weakly developed fine nutty structure, friable to plastic, boundary sharp

ON 20 ins. + pale olive sandy clay, plastic, faint medium sized yellowish red mottles.

The present land use is rough grazing only, but the remains of rice fields can be seen.

A sample from the east of Togoru Creek, Queen's Road, was analysed and the results are shown in the Table.

These figures indicate an acute lack of phosphate and lime, and topdressings of those amendments may be the means of bringing into production present waste land.

Deuba sandy loam and sand are formed on coastal deposits of alluvium brought down by the Navua River. These are coarse and siliceous, and a typical profile on them, from the east side of Togoru Creek is:—

16 ins. dark grey brown sandy loam; plastic; distinct, medium sized red brown mottles, common; passing to

20 ins. light yellow brown sandy loam; slightly plastic; distinct medium sized reddish yellow mottles, common;

ON bluish grey sand, containing some clay.

Textures range from sandy loams to sands, and around the swamp the soils become slightly peaty.

Deuba sandy loam is strongly acid and leached of plant nutrients, as shown by the following samples from 1½ miles east of Deuba Hotel, and 1 mile west of the Pix Plantations, Vunidilo, whose analyses are quoted in the Table.

These samples indicate that Deuba soils have a low base capacity exchange so that applications of phosphate and lime should enable the ready establishment of pastures and improvements in yields of cassava and other root crops. At present where conditions are too dry for rice production this soil supports weeds and rough pasturage.

Melimeli peat is formed where the coastal sand ridges have ponded lagoons in the Melimeli, Togoru and Wainisau streams. These lagoons have gradually filled with organic matter which has decomposed to peat. A profile from alongside an old tramline, one mile west of Melimeli is:—

8 ins. dark reddish brown peat; having a nutty structure on dry surfaces

10 ins. dark reddish brown peat; 1/3 fibrous matter. 2/3 gelatinous matter;

12 ins. dark reddish brown peat; 1/4 mushy root remains,

ON greyish sand.

The depth of peat ranges from 18 ins. to more than 36 ins. and the substrate is sandy. Access is difficult and the exact boundaries are not determined. At present they support a vegetation of rushes, ferns, sago palms, pandanus, and shrubby trees and are used only for rough grazing in dry periods. Analyses, as shown in the table, were carried out on samples 1 mile west of Melimeli village and from ½ mile on the north side of Queen's Road opposite Waimate beach.

Analytical data for peats should not be assessed in the same way as for mineral soils. Most of the nutrients are bound up in the organic matter and are unavailable

to plants. Thus, the high figures for acid soluble phosphate are almost certainly not indicative of an adequate level and of no response to phosphatic fertilizing; likewise, the high exchangeable potassium does not imply luxury quantities of this element for plant food.

The main thing shown by the analyses is that the peats are very highly acid. The very low base saturation shows that large applications of fertilizer would be necessary before the peats could be considered as even moderately fertile, beside the problems posed by their extremely poor drainage, so that cultivation of these at present, would probably be prohibitively expensive.

LABORATORY INVESTIGATIONS

1. METHODS

pH was determined by a glass electrode using the standard soil: water ratio of 1:2·5, organic carbon by the Walkley-Black wet oxidation method, total nitrogen by a micro-Kjeldahl. "Available" phosphate was determined by a modified Truog method and total phosphate by a colorimetric procedure after fusion. Base exchange data were obtained by the use of neutral normal ammonium acetate, calcium and mangesium being separately estimated by "versene" solution, potassium by cobaltnitrite, and sodium by Kahane's procedure. Mechanical analysis was carried out by the International pipette method, the data being uncorrected for organic matter, and the other physical data were obtained from Keen-Raczkowski experiments.

2. OBSERVATIONS AND INTERPRETATION OF RESULTS

(*a*) *Introduction*

In a Soil Survey of the present nature, it is obvious that only a relatively small number of samples can be dealt with in the laboratory, hence the results are often not statistically highly significant. Thus only nine profiles from this area involving nineteen soil samples, were analysed. Navua plains however, is a moderately small area, compared with the total area of Viti Levu and viewed in this light, the sampling was rather more detailed than usual. Furthermore, the soils are all formed in roughly the same manner, constituting an interdependent association and so they have marked similarities. In the main, the two differences which separate them are textural, i.e. whether sands or clays, and the degree of poor drainage. All the soils analysed are in fact gleyed to some extent.

The chemical and physical properties of gleyed soils differ in many ways from those of freely drained soils. In general, poorly drained soils are rarely very acidic, they are not eluviated, so that the base status of the topsoil is usually similar to that of lower horizons.

The lack of oxygen which obtains under these conditions for at least six months of the year has two main effects; firstly, it reduces the soil population, so that decomposition of plant material is slowed up, causing a high soil organic matter content with a high carbon-nitrogen ratio, and secondly it makes for reducing conditions in the soil. Compounds like ferric phosphate are thus reduced to ferrous phosphate to some extent, which releases one phosphate ion per three ferric phosphate molecules reduced. In additions, the ferrous phosphate is more soluble than ferric phosphate, so that acid soluble phosphate tends to rise down the profile of a gleyed soil. However, the total phosphates are nearly always low.

(*b*) *Acidity and Base Exchange*

The soils of the Navua plains are highly acidic, and with a low base status. This is shown by low pH's and low base saturation percentages. With the exception of the Vakabalea profile of Navua clay loam, the base saturations are all less than 35 per cent and far lower in the sandy profiles than in the clayey profiles. Base exchange capacities also fall regularly with clay content, after allowing for that due to organic matter, and are in general for Fiji, moderate to very low.

It is likely that leaching goes on to a certain extent in the drier months of the year, especially in the sands, and in this case the low base saturations can be explained, especially in view of the fact that a highly acidic vegetational association is present.

Pastures on such soils as these would therefore be expected to respond markedly to liming. It is not known how far rice is acid tolerant, i.e. what is the optimum soil pH for the growth of this crop, but it seems very likely that an increase in the calcium status of these soils would have a beneficial effect on rice, if only by release of phosphorus consequent on a rise in pH or by improvement of the soil structure, to mention only two other beneficial effects of liming. These conjectures can only be verified or disproved by properly designed field experiments.

(*c*) *Phosphate*

The interpretation of phosphate analytical data is very difficult. Two determinations are normally carried out, total phosphorus and that fraction soluble in n/100 sulphuric acid (Truog's method). The former undoubtedly constitutes the total phosphorus reserves of the soil and the latter is supposed to give an indication of that fraction of the soil phosphorus available to plants. However, workers in other countries have found that crop responses to phosphorus do not correlate very well in some cases with predictions using acid-soluble phosphorus figures.

The problem is further complicated by "phosphate fixation". This phenomenon is the rendering unavailable to plants of easily soluble phosphates in the soil. In general, a dressing of phosphate on a field as fertilizer calculated by phosphate requirements of the crop plant, gives very poor results. A 10 per cent utilization of a phosphate dressing may be considered as highly satisfactory even over 10 to 15 years.

The reason for this is that the phosphate anion combines to a greater or lesser extent in soils with various cations and other substances, the products of which are relatively insoluble and hence unavailable to plants. There are various mechanisms by which this happens and they differ between tropical countries and temperate countries. Differences in phosphate fixation, as it is called, are also found between freely drained soils and poorly drained soils as on the Navua Plains. Overseas experience indicates that the water logging of a dry soil lowers fixation to some extent and that in a particular profile the amount of fixation decreases with increase in depth and wetness. The rate at which this process takes place is, in general, fairly fast, so that phosphate added in a fertilizer dressing usually is rendered unavailable to plants before they can make full use of it.

Peat soils usually show high acid soluble phosphate but this would appear to be unavailable to plants since they usually respond to phosphate dressings.

To consider now the laboratory results for the Navua soils, it is clear that both the acid soluble and the total phosphates are very low, averaging (for the mineral soils) 1·2 mgr./100 gr. soil and 89 mgr./100 gr. soil respectively (compare the average for all soils analysed in the Soil Survey of Viti Levu, of 3·0 and 161 mgr./100 gr. respectively). The amounts of total phosphate decrease with decreasing clay percentages with some aberrations where there are high organic matter contents. This would seem to show that the clay (which includes the iron and aluminium oxides) is in most cases, still the predominant seat of fixation, as the acid soluble phosphates show no such correlation with clay content.

There are two obvious methods to overcome this to some extent:—

(*a*) by placing phosphate fertilizer as near the feeding roots as possible, such as in band dressings and

(*b*) by using substances which are relatively insoluble in themselves, but which continually release quantities of phosphate, usually by acid decomposition, which the plant roots in the vicinity can use immediately. Such substances are apatite and rock phosphate.

It is recommended that properly designed field trials on the phosphate fertilization of rice be laid down to decide what the optimum dressings are, and also to test the validity of the chemical methods used for phosphate estimations, and perhaps to design new ones.

(*d*) *Organic matter and nitrogen*

In general the soils are well supplied with organic matter, but the very high C:N ratios indicate the lack of decomposition under poorly drained conditions. The nitrogen contents are however, adequate despite the high C:N ratios, though how much of this is in an available forms, it is not possible to say. Rice typically responds to nitrogen.

(*e*) *Potash and Sodium*

The former nutrient, as indicated by the analytical data, is well supplied in Navua soils, and there should not be any serious need of potash fertilizer at present.

(*f*) *Mechanical Analysis*

No signs are detected from the sodium data of encroaching seawater, as might have been expected from the location.

The soils fall into three groups, those with above 30 per cent of clay, those with 20 per cent to 30 per cent and those with less than 15 per cent. Silt percentages are somewhat less than, and follow the trends of, the clay contents. The soils of the first and second groups would be, on a mechanical basis, therefore, the best for rice growing, as the sands of the third group tend to lose water very quiekly and may even be droughty in dry wheather.

(*g*) *Water holding capacity*

The amounts of water the soil can hold are very high, even the sands well supplied with organic matter. It appears that organic matter acts just like clay with regard to moisture retention and this fact increases the usefulness of the sands, so long as the content of organic matter is kept up.

CONCLUSIONS AND PROSPECTS FOR DEVELOPMENT

All the Navua and Tokotoko clay loams are being used for dairying or rice production except for about 750 acres in Melimeli Creek and 750 acres in the Lobau valley. The remaining areas of undeveloped land consist of approximately 3,250 acres of Melimeli peats, 2,000 acres of Deuba sandy loam and sand and 1,000 acres of Tokotoko sandy clay loam.

Mr. P. McNee, of the Irrigation and Drainage Department, Malaya, who was consulted by the Fiji Government on the prospects for the draining and irrigation of the Navua Plains, recommends a controlled drainage and irrigation programme for rice. The cost of this will be borne by the Colonial Development Rice Scheme Fund of £3 million.

The fertility requirements of rice are not fully known. However, experience in Asia shows that nitrogen as ammonium sulphate gives increased yields in almost every case, phosphate gives increased yields on deficient soils and it requires several years to bring the yield up to the maximum in spite of heavy dressings. Organic manures usually give responses, potassium only on iron leached soils of very low exchangeable cation content. Experiments in Asia on liming acid rice soils are not encouraging (see the Report of the second meeting of the Working Party on fertilizers of the International Rice Commission of F.A.O., May 1953).

The available chemical data indicate that these soils, compared with those at Sigatoka, are low in lime and phosphate, sometimes in magnesium. Fertiliser trials should be carried out on these soils to study the effects of ground limestone and phosphate manures, other than superphosphate, on pasture and rice production.

The peats offer difficulties in development because they are very close to sea level, and on draining they can be expected to shrink 9 inches to 24 inches below their present surface. In addition these soils are low in plant nutrients and will require expensive top-dressings for adequate production.

A possible method of reclamation is that of warping. This is the flooding of the low lying peaty areas with silt laden waters which, on being allowed to stand, deposit a thin layer of sediment. The process is repeated during and after each storm until a sufficient depth of fresh sediment has been built up to enable farming to be carried out.

The Melimeli Creek provides a suitable source of water and the main outlay involved is the construction of dykes to contain the flood waters.

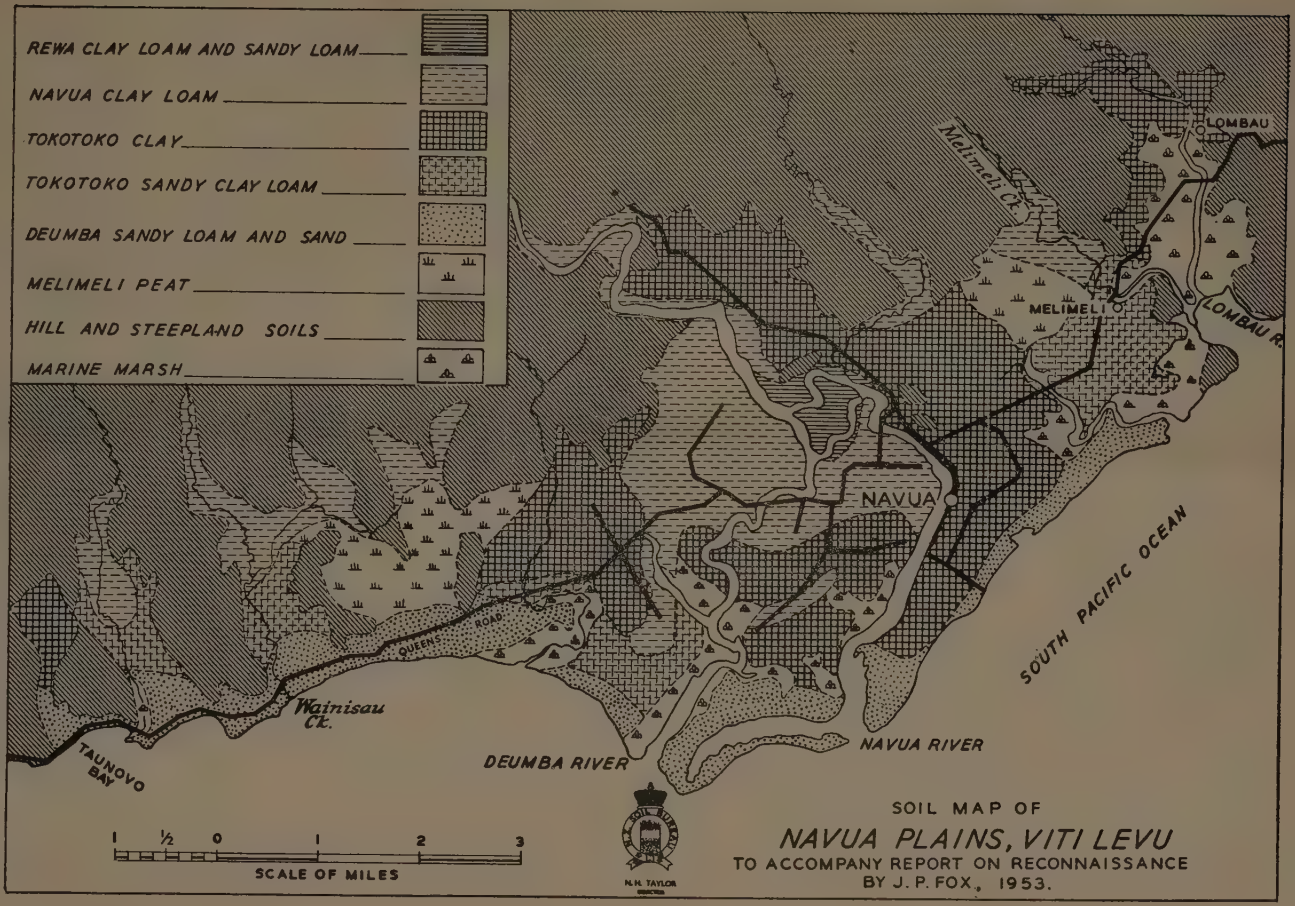
It is suggested that the engineering possibilities of this method of reclamation be investigated both for the Navua swamps and the Toga swamp.

The Deuba sandy loam and sand are more readily drained, but being strongly leached they will also require lime, phosphate, and perhaps nitrogen dressings. Being sandy these soils are liable to become droughty should dry weather be prolonged. This could be offset by close regulation of the drainage ditches to use the available water to the best advantage. Such a method of farming requires considerable co-ordination of drainage, and this could be organized by a local board, suitably advised by a competent agriculturist. In addition such a board could act as a central agent for marketing, supplies of fertilizer and as a farm advisory agent.

Production from the Tokotoko sandy clay loam about Togoru Creek is limited at present by lack of plant nutrients. Experiments should be designed to demonstrate methods of raising fertility by topdressing particularly with lime and phosphate.

At present these soils have a high water table and could be used for rice production. Any lowering of water tables by drainage will make these soils free-draining, and thus more suited to pasture production than to rice production.

In addition to the development of further land, consideration should be given to methods of improving practices on the present holdings. One such aid would be a local board for controlling, maintaining and extending the present drainage system.


REWA CLAY LOAM AND SANDY LOAM
NAVUA CLAY LOAM
TOKOTOKO CLAY
TOKOTOKO SANDY CLAY LOAM
DEUMBA SANDY LOAM AND SAND
MELIMELI PEAT
HILL AND STEEPLAND SOILS
MARINE MARSH
LOMBAU
Melimeli Ck.
MELIMELI
LOMBAU R.
NAVUA
SOUTH PACIFIC OCEAN
QUEEN'S ROAD
Wainisau Ck.
TAUNOVO BAY
DEUMBA RIVER
NAVUA RIVER
1 ½ 0 1 2 3
SCALE OF MILES
SOIL BUREAU
N. H. TAYLOR
DIRECTOR
SOIL MAP OF
NAVUA PLAINS, VITI LEVU
TO ACCOMPANY REPORT ON RECONNAISSANCE
BY J. P. FOX, 1953.

LAND DEVELOPMENT . . .

SOIL EROSION AND SOIL CONSERVATION IN FIJI

BY C. E. WHITEHEAD

The two major Islands of the Fiji Group, each more or less evenly divided in area into wet and dry zones, have always possessed a high erosion potential. The wet zone area of Viti Levu lies east of a north-south line drawn through the centre of the island, while the corresponding zone of Vanua Levu lies south of an east-west line drawn horizontally through the centre of that island. In both cases the cleavage is sharp and distinct. Both wet and dry zones, although possessing great coastal and river flats, are predominantly hilly to mountainous in topography. Each island has one main watershed; that of Viti Levu, like the hub of a wheel, being located in the central north of the island from where countless ranges and spurs radiate out, and that of Vanua Levu forming the dividing line of the wet and dry zones, in a herring-bone pattern of main range and offshoots.

Wet Zones—The wet zones receive an annual rainfall of up to 150 inches, the main precipitations occurring during the summer and later summer months. It is during this time of the year that intermittent spells of violent and prolonged rainfall literally pound the earth. Rarely is there at any time of the year a true dry spell of more than six weeks duration. Agricultural development up to the present has been chiefly confined to the river valleys and deltas, and to the coastal plains. Bananas, (of prime economic importance to Viti Levu Fijians) formerly grown on the well-drained river flats and deltas, have been superseded by sugar cane as a crop in these areas, and are now extensively grown along the shoulders of the major river valleys and on the creek flats. On both islands, areas of deltas and coastal plains too low-lying for the production of sugarcane or coconuts have been given over to the production of swamp rice. Sugar cane is the major crop of Viti Levu (wet zone), while in Vanua Levu the coconut is paramount. Suva Peninsula, the site of early day *yaqona** plantations, has been and still is intensely cultivated by market gardeners for urban supplies of vegetables. A comparatively small dairying industry is located in two areas—the Navua coastal flats and the rolling hill lands and minor flats of the Tailevu District. On the whole the wet zones are still covered with dense virgin jungle and coarse cane grasses. Dispersed throughout these regions are Fijian villages whose inhabitants continue to produce their own food requirements from *tei-tei* (gardens) by a time honoured and most praiseworthy system of corridor clearing and shifting cultivation. Further development of these virgin jungle lands would appear to lie in the direction of economic tree crop and pasture establishment. In wet zones, soil erosion, although extremely severe in particular localities, is more or less limited to man's small dominion of development. The Suva Peninsula is an example of what can happen when tropical soils are bared to and unprotected from intense sunlight and torrential rains. In this region much of the soil cultivated for vegetable supplies has been washed away, and in many instances only unsightly sheets of bare " rock " remain where once flourishing gardens were located. Much of the well-drained *bila* land of the large river valleys was " flogged " by years of banana growing which greatly reduced the humic content of the soil. With the supersession of bananas by sugar-cane on these area, the cultural practices involved in the production of the latter crop have not altogether prevented further loss of soil by sheet erosion and depletion of organic matter by oxidation. In parts of Tailevu dairying district, over-stocking, cattle tracks and sledgeways have caused slump and gully erosion of the hill paddocks. At times of flooding the heavily laden silt waters of the Rewa River indicate that all is not well with the soil in the banana areas along its upper reaches and tributaries.

Dry Zones—These zones are not dry in a strict sense for each enjoys an annual rainfall of some 70 inches. At the close of the wet summer months, however, the rainfall tapers off into a dry winter, and by the time the first violent November storms occur, drought conditions can, and often do prevail. Apart from the coastal fringe of rich flat soils and the highly productive valleys of some three major rivers and a host of minor streams, the land of the dry zones is an open hilly savannah type with soil of shallow depth and moderate fertility, originally supporting a dense stand of native reed interspersed on the watersheds by open forest type stands of *Noko Noko*. On the coastal plains and river valleys of both dry zones agricultural development is an intense monoculture of sugarcane, for it is in these zones, with their favourable cultural and cane ripening conditions, that the sugar industry is cradled. Cash cropping and rice growing is blended in with cane culture in a minor way but is mainly confined to the higher and broken marginal lands. Upland rice culture is an undertaking of no mean proportion in the dry zone, and it is significant that the greater part of the Colony's rice supply comes from this area. It is here also that the major supplies of pulses and grain are produced. Large undeveloped areas in the interior of the dry zones are haphazardly grazed by inadequately controlled cattle, horses and goats. These belong largely to Indian owners or to Fijians, but in some several instances the herds of beef cattle are owned by European ranchers. Development of the dry zones is toward the hilly savannah, suggesting that stock raising and forest establishment will be of coming importance in these areas. Soil erosion in the dry zones is widespread, occasionally intense and spectacular. The burning of the savannah lands, which has developed into an annual event, is attributed to the indiscriminate use of fire for flushing wild pigs from reed banks, clearing of land for *tei tei* (food gardens), clearing land to uncover wild yam sites, and the burning off of rank mats of dead grass prior to the spring storms. The devastation caused by this persistent firing is plainly visible in vast areas of *Vei Sigasiga* "earth to sky" wastes where the soil has been repeatedly stripped of its grass cover and exposed to the onslaught of violent spring and summer storms. In these regions only a few inches of sterile sub-soil remain. Watersheds formerly covered with stands of trees vital to the retention of soil and water have been denuded by fire until only rock outcrops and slopes of rubble beds remain. Overstocking and uncontrolled stocking has substantially added to the damage caused by fire.

The havoc wrought by erosion in the higher marginal lands is having a profound effect on the coastal strips. Major rivers which once carried large craft are chocked with great shingle and sand bars which deflect currents into the banks to rip away extensive areas of rich alluvial land. On the coastal plains, which are but slighly elevated above sea level, proper drainage is becoming increasingly difficult. Overall there is a greatly increased flood hazard. The utilization of all good flat land for the production of sugarcane and the relegation of food and cash crops to the marginal areas has created a pattern of agricultural unbalance which has predisposed the dry zone lands to severe erosion from the very start of agricultural development in these areas. Already the production of food crops for home consumption has attained a level high in economic importance, and with the present rate of increase in population and the exhaustion of marginal grazing lands due to wrong land use, there must shortly be made a rearrangement in the existing agricultural design. A severe slump in overseas markets would no doubt result in a modification of the monoculture of sugarcane into a more mixed type of agriculture. Because of the high ruling price for sugar, this monoculture has been further enlarged upon by the recent extension of cane into the further most reaches of occupied marginal land at the cost of near famine conditions in supplies of pulses and grains formerly grown on these areas. The "straight row-up-and-down" cultural practices almost universally adopted by cane-growers will, in being applied to these shallow range soils, bring on their speedy ruination by erosion. Population, by indenture and later by natural increase, has far outstripped the requirement of the sugar industry despite its rapid and huge

growth. That section of the population unable to find employment or residence on the sugar estates, or to procure good blocks of land on the flats on which to grow cane, have found employment in the sugar mills and subsidiary industries, and in seeking places on which to live, have spread out over the marginal range land in the immediate vicinity of the cane belts. The leasing out of these marginal lands saw the creation of what is popularly termed "Indian peasantry" but what is, in fact, a fraternity of legal squatters, a host of part-time farmers engaged in a confused and uneconomic subsistence, agriculture which could not survive but for a supplementary income derived by outside seasonal employment. Areas of these lands leased out in the past were inadequate (about 12 acres average) and the lease holders, with their ever increasing families, livestock and goats, and with their haphazard cropping and destructive cultural technique, have so depleted and eroded the soil that to-day there are large areas of marginal lands whose agricultural and pastoral extinction is within sight.

Departmental Activities—In 1937[1] the Department of Agriculture stressed the "serious nature of soil erosion in Fiji" and the need for conservation in certain areas; and a number of school gardens and demonstration farm areas were contoured (grass strips, broad based terraces and contour bunds and drains) as a first step in the education of farmers in erosion control[2]. In 1947, these conservation projects were extended to provide for the contouring of selected farms in each settlement or district of Viti Levu[3]. The majority of farms selected were contoured to live stop-wash lines of Vetiver grass (bench terracing) although several farms were bund-terraced by bullocks and plough. Extension Officers followed up this work by contouring further farms, by encouraging farmers to adopt contour practices, and by giving lectures to farmers in settlements and at schools. The subsequent low-base terracing of an 80-acre farm by tractor and grader demonstrated the practicability of large scale contouring of marginal lands by mechanical means[4]. With the appointment of a full time Soil Conservation Officer and Assistant in 1949, the following programme has been developed:—

Education Information Services provide for:—
- demonstration of soil conservation by field officers by the contouring of selected farms;
- large scale terracing demonstration by mechanical means;
- propaganda—lectures by all field officers in their area of operation;
- publication of pamphlets, posters and booklets dealing with soil erosion and its control;
- motion picture screening in settlements, schools, and public places;
- conservation displays at shows, schools, and in towns; and
- field days for farmers and School Farm Clubs.

Legislation‡ has been introduced:—
- to cover the conservation and improvement of all land;
- to enforce where necessary the adoption of conservation measures;
- to create a Conservation Board to handle all aspects of land conservation and improvement, and to create Conservation Districts.

Development plans provide for the extention of soil conservation practice and work within the Colony, with the costs borne by the farmers.

Surveys have been carried out as follows:
- Erosion surveys to determine location and extent of erosion;
- Land Use surveys to prepare plans for agricultural and ecological rearrangement necessary and for devising plans for future use of unoccupied lands; and
- Soil Surveys to assist in erosion control and the agricultural and pastoral development of the Colony.

Rearrangement of land-use calls for the preparation of new areas for agricultural settlement and transfer of population from problems area into prepared settlements when agriculturally and politically expedient to do so.

The first phase of the Department's programme is well under way in the island of Viti Levu. Since 1949 well over one thousand acres in the Nadi basin area have been contoured by the Soil Conservation team to narrow-base terraces. In addition to this, individual farms have been bench-terraced by Field Officers in their respective districts. Erosion and conservation propaganda has been intensified and carried to farming communities, schools and the public by means of lectures, posters, displays, and film screenings from portable projectors. The recent acquisition of a mobile 16 mm. projection unit will greatly facilitate dissemination of further information,, As a result of the Department's activities over the past five years there are now few farmers on Viti Levu who can claim ignorance of soil conservation practice. The expense of this educational phase has so far been carried by Government. The cost of further conservation work in existing demonstration districts may well have to be borne by the farming communities—for example, through an increase in rental of lease land.

Plans are tentatively laid for the implementation of this first educational phase of the soil conservation programme in the island of Vanua Levu, and should additional staff and machinery become available, a start will be made with this work in 1954.

With the ratification of the Land Conservation and Improvement Ordinance 1953 and the establishment of a Conservation Board, the laws and machinery were created for the effective use and preservation of the Colony's lands. A major problem area known as the Nadi Basin has been singled out for rehabilitation. Already much conservation work has been done in this area, and the farmers are, on the whole, conservation conscious. On the completion of a land-use survey of this area, a plan for application to the area is to be devised.

It is proposed to divide the area into three Conservation Districts, one of which, at the northern end, will be the first Conservation District to be established in this Colony.

As a preliminary to the Nadi Basin scheme, a pilot survey (Uciwai No. 2) based on the standard American survey technique was made of a small area in the southern end of the Nadi area. This erosion and land utilization survey disclosed gross overstocking and overpopulation, and indicated drastic ecological rearrangement of the area as a first necessity in any plan of operation.

Other surveys carried out covered:—

Namau Tikina, for resettlement purposes;

Nadroga–Navosa—to assess the potential of these areas for the development of large scale stock raising; and

Macuata—Erosion survey as a preliminary to conservation activities on Vanua Levu.

Experimental Stations of the Department are actively engaged in pasture research and the exploration of all angles of scientific stock-raising on the savannah lands of the dry zone and, the research into tree crops for future development of the wet zone. Whatever final plans of development are presented for both zones, soil conservation will be an important feature of such plans. Any future development of the wet zone jungles for cocoa or coffee plantations will call for properly designed terrace layouts. Should the day come when Fijian garden areas become so restricted by development of surrounding lands as to prevent the present shifting cultivation method being continued, then contour ridge planting supported by adequate storm drains will replace it.

The control of firing, for so long a problem, will always be difficult to effect. By education and propaganda, however, and by the extension of forest plantings and the employment of patrolling rangers, firing may be ultimately kept within reasonable bounds[5].

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4. Whitehead, C. E. (1949)—"A Soil Conservation Project in Nadroga,"—ib. Vol. 20, No. 1–9.
5. Whitehead, C. E. (1952)—"Rangeland Firing in Fiji"—ib. Vol. 23, No. 2–8.

NOTES ON WEED CONTROL IN FIJI

By T. L. MUNE

The Weed Control Officer returned from vacation leave on August 17th, 1953.

The F. A. Weed Control, Filipe Kuruvoli was absent on vacation leave from September to December and was replaced by F. A. Paula Cio.

EXPERIMENTAL

1. Trials with T.C.A. for the eradication of giant sensitive were made.

(*a*) An area of one square chain was cleared of all vegetation and T.C.A., at the rate of 80 lb. to the acre, was applied to the bare ground. This checked all growth, but did not prevent seeds germinating.

(*b*) One square chain of grasses and *Mimosa invisa*, six inches in height was sprayed with the same rate of application as in (*a*) without pretreatment. This resulted in a kill of all vegetation. Regrowth of grasses (Para and sedge) took place after twenty-one days checking further growth of *Mimosa invisa*.

(*c*) One square chain of large flowering plants was treated with T.C.A. applied to the roots. The plants were defoliated within two or three days. Observations are not yet complete.

Cost of above method of control £17 18s. per acre.

2. Trials for control of sedge in pastures were carried out at Adi Cakobau School with T.C.A. Trials are not yet complete.

A series of trials were made at the Approved School, with the co-operation of the Principal, for the control of (1) general weeds of pastures and (2) to ascertain the rate of application and effectiveness of (*a*) Weedone Standard 2,4,D + 2,4,5,—T (*b*) Weedone Special 2,4,5,T (*c*) Agroxone Triple Strength M.C.P.A. 30 per cent (*d*) Phenoxyle dust.

An area of one acre and eight square chains was first cleared by cutting at ground level and burning. The resultant seedling and regrowth was sprayed with (*a*) Weedone Standard at the rate of 1–80. (*b*) Weedone Special at the rate of 1–200 (b2) Weedone Special at the rate of 1–400 (C1) Agroxone Triple Strength at 1–100 and (C2) at 1–200. (*d*) Phenoxyle dust at 20 lb. per acre. The lower rates of application were as effective as the higher. The dust was very slow in action and less satisfactory.

All bare ground was planted with Batiki blue grass.

Trials indicate that *Solnum T* at all stages of growth can be controlled with 2,4,5 T at rates from ·9 lb. to 3·6 lb. of acid per acre. At 3·6 lb. it would not be economical under normal conditions.

The position regarding the principal proclaimed noxious weeds during the last three months is summarized in the following notes.

Farm to farm inspections were carried out in Rewa, Tailevu, Ra, Macuata and Bua districts. Inspections were made of Government controlled land and efforts made to have Officers in charge eradicate the weeds. Weed Control labour were employed by Ratu Kadavulevu School, Lodoni from 11th to 28th of November. Costs were met by the school.

GIANT SENSITIVE

Inspections of the infected areas of Nadi and Tailevu were carried out. One plant was found and destroyed in each of these areas.

A fresh infestation at the Methodist Agricultural School, Navuso, has been dealt with. The main infestation of two acres was fenced and hand pulled by school boys. Three plots were treated with T.C.A. at the rate of 80 lb. per acre. Four small areas have been inspected at monthly intervals and 1,051 plants pulled by hand.

No inspections were made of Na Cocolevu or Taveuni infestations.

TOBACCO WEED

Weed Control services have made strenuous efforts to eradicate this plant from the Government compounds of Korovou, Tailevu; and, with the collaboration of the Road Superintendent have destroyed plants occurring on the road verges between Naduruloulou and Korovou.

A small infestation found at Nadali, Rewa, was destroyed.

Holding to holding inspection was carried out at Nasinu and landholders were instructed to eradicate the pest.

This weed is now well established in Navua and on roadsides to Nabukavesi.

During November a tour of inspection and survey was made in the Vanua Levu districts of Bua and Macuata. At Wainunu the weed has become a major pest on Kaciwaqa and Muanicula Estates. It has spread across the river and along the roadsides to the koro of Nakawakawa with a small area at Nämua, north of Mabuawalu.

At Nasarawaqa the infestation is small and it may be possible, with prompt action, to eradicate it.

WATER HYACINTH

The Rewa River Board, which is charged with the control of this weed in the water ways of the Lower Rewa River was apparently not able to cope with the heavy infestations, and at their request, Weed Control took over. Considerable progress was made. Twenty-five miles of water ways were sprayed but the work was not completed, owing to the lack of funds. The cost was met by the River Board. It is estimated that approximately £400 will be needed in 1954 to control efficiently this pest in these channels.

The patrol service, maintained by the Colonial Sugar Refining Co. Ltd., in part of the Tailevu District, was satisfactorily carried out during the year.

ELLINGTON CURSE

An inspection of Ra–Tavua districts was carried out.

A serious effort has been made by the Road Overseer, Raki Raki to destroy plants growing on road reserves.

The Colonial Sugar Refining Coy. has dealt with the weed on the Nabuna Estate.

Farm to farm inspection was carried out from Rabulu to Korovou, Tavua.

MINT WEED

This plant is very widely spread and is becoming a major weed. It is, fortunately, easily controlled at all stages of growth with hormone weed killers at economic rates of application.

BROOM WEED

Infestations in Ba district have been checked and in some areas controlled by better pasture management.

On Vanua Levu in districts of Bua and Macuata this plant is very widespread.

PRICKLY PEAR

No new infestations have been reported and known infestations are satisfactorily controlled.

SOLANUM TORVUM

Suva to Rewa area land holders have neglected the control of this weed and it was necessary to issue 33 written notices. In most cases an attempt has been made at eradication, in others the period of time has not yet expired.

This weed was found at Solevu, Bua, Vanua Levu, while on a survey of noxious weeds in this district. It was formerly understood that it did not occur here.

LANTANA

Considerable progress has been made with the control of this weed in the proclaimed area of Tailevu, and with the collaboration of the Road Superintendent, the main area of infestation on the verges of Deepwater Road have been brought under control.

The plant continues to be a major pest on the coconut plantations. Economic control can be achieved by spraying seedlings and regrowth with 2,4,D during the period between October and January. Trials with 2,4,5,T appear to indicate that the plant may be controlled at all stages of growth. Small quantities of 2,4,5,T have been supplied to planters.

AGRICULTURAL LEGISLATION

During 1953 *the following legislative action of concern to agriculture and forestry was taken.*

1. *Rhinoceros Beetle Eradication Ordinance No.* 4 *of* 1953 came into operation on 8th May, 1953. This provides for the establishment of a fund (from a cess on copra plus a Government subsidy) and of a Board to control the fund and to organize the work necessary to eradicate the beetle.

Under the Noxious Weeds and Diseases of Plants Ordinance (Cap. 133), the Rhinoceros Beetle Regulations 1953 were proclaimed (Legal Notice No. 35). These regulations define the responsibilities of land holders and occupiers to destroy inter alia all dead coconut palms, and to report the occurrence of the beetle. The transfer of soil and compost material and the movements of shipping are controlled: and the duties and powers of inspectors are laid down. Under the same Ordinance the Island of Viti Levu was proclaimed as an area infected with the insect pest known as the Rhinoceros Beetle (*Oryctes rhinoceros* L.).

2. *Land Conservation and Improvement Ordinance No.* 16 *of* 1953.

This long awaited Ordinance came into effect on 10th July, 1953. It provides for the establishment of a Land Conservation Board, the appointment of Conservation Committees and the designation of conservation districts.

The functions and powers of the Board are defined. The Board may make conservation orders to prohibit, regulate and control the cultivation of land, the grazing and watering of livestock, and use of sledges and the closure of land. The Board may, by order in writing, require any land owner or occupier to construct and maintain on his land such works for the conservation of land or water resources as are specified in the conservation order.

3. *Forestry Ordinance No.* 17 *of* 1953.—

This Ordinance, which came into effect on 10th July, 1953, provides for the appointment of officers—the establishment of an Advisory Board and the setting up of Forestry Committees.

The Ordinance provides for the constitution of reserved forests, nature reserves and sylvicultural areas. Offences and penalties are laid down and the arrangement for payment of fees and royalties described. The hunting rights of Fijians established by custom: the right to collect wild fruits and vegetables and also fishing rights on land not being part of a nature reserve or sylvicultural area are protected.

OBITUARY

FIELD ASSISTANT RATU ILAIJIA VAKALIWALIWA

It is with the deepest regret that we record the death of Field Assistant Ratu Ilaijia Vakaliwaliwa at the Colonial War Memorial Hospital, Suva, on February 11th, 1954. There are few officers of the Department with longer and none with more faithful and conscientious service than Ilaijia, who in his 20 years with the Department, has earned steady promotion until at his death, he was at the top of his division.

For the last five years of his service he was stationed on the Principal Agricultural Station at Koronivia. Not only had he developed into a competent and reliable experimental field technician but on account of his fine personal qualities he had come to occupy a respected place in the Koronivia community.

SHIRI DHAR PAHALAD

Shiri Dhar Pahalad was Laboratory Assistant and later Senior Laboratory Assistant in the Chemical Section of the Department from April 1951 till the time of his death on 16th February, 1954.

He was a much valued officer in the Laboratory and also of such a cheery disposition that all of his colleagues heard of his sudden death with the deepest regter and with a feeling of a personal loss.

GENERAL . . .

SOIL CONSERVATION PROBLEMS TACKLED BY NEW AUTHORITY

Soil conservation was one of the main subjects discussed at the first meeting of the Land Conservation Board on 26th January, 1954. The Board was set up last year.

The Director of Agriculture presided at the meeting and other members present were the Director of Lands, the Conservator of Forests, Mr. T. E. Foster and J. V. Hunt Sila, Mr. J. L. Chalmers attended by invitation in place of Mr. C. E. Elliot, who is absent from the Colony. The other members of the board are Messrs. A. D. Patel and S. A. Tetzner.

Mr. C. E. Whitehead, Soil Conservation Officer, was appointed secretary to the board.

CONSERVATION WORK

The chairman gave a brief history of soil conservation work in the Colony.

Throughout the years there had been demonstrations by Agricultural Officers and these had led up to the intensive operations of the soil conservation unit in the Nadi Sabeto Basin.

In the last four years the conservation staff have terraced about 1,000 acres and by field propaganda and instruction have made the farmers of the area aware of the dangers of erosion and have led them to appreciate the value of the conservation measures applied to the land.

The cost of the work performed in the Nadi–Sabeto Basin has been met by the Government, the work being regarded as a large-scale demonstration of soil conservation practice, and a first step is establishing knowledge and confidence among farmers.

NEW COMMITTEES

To assist the board, soil conservation committees are to be set up.

It was decided that the three conservation committee districts should be the Nadi–Sabeto Basin, the Macuata Province and the Suva–Nasinu–Colo-i-Suva area. Committees for the first two districts will be appointed shortly.

Conservation staff is not yet available for the Suva Peninsula area.

A majority of the members of the district committees will be land owners or occupiers. The duties of the committees will be to advise the board on land conservation matters within the district, to collaborate with the conservation staff in the preparation of soil conservation plans and to support the efforts of the staff by educational work among the people of the district.

The board discussed the question of payment for conservation work and it was agreed that after an adequate period of demonstration and instruction, any work carried out under the provisions of the Ordinance should be charged against the the owner or occupier of the land on which the work was done.

FREE IN MACUATA

It was agreed that in the case of Macuata Province, where no educational or demonstration work has so far been carried out, the service should be free for the first two years.

The board agreed that most small farmers would require either a loan or time in which to repay the cost of conservation work done on their property, and it was decided that the method of recovery should be further discussed with the Government.

It was agreed to recommend that no recovery should be claimed against the owner of occupier of treated land for the first 12 months, but that recovery should be made during the succeeding two years.

The possibility of loans from the Agricultural and Industrial Loans Board being granted for the payment of conservation charges is to be taken up with that board.

VALUABLE LAND LOST

The Board discussed the loss of valuable land by river bank erosion at Bemana on the Sigatoka River and at other places.

The members agreed that the protection of riverbanks and watersheds was a serious need and the Conservator of Forests gave instances of the havoc already wrought within the Colony. There was general agreement that riverbank erosion was only a symptom and that the real cure was proper land-use to reduce excessive run off from the watersheds.

The board decided to give notice that it was considering issuing a Conservation Order respecting the cultivation of river and stream banks within certain distances from the water's edge.

PROTECTIVE WORK

The Board decided to ask the Government whether the functions of existing River Boards included the carrying out of protective work and whether Government funds could be made available for river erosion control.

It was decided also to ask the Government to consider the appointment of an expert to visit the Colony to advise on the control of erosion along the Colony's rivers.

The board discussed the question of the control of indiscriminate firing of grass lands and the members agreed that it was very difficult to enforce legislation controlling the firing of grass and bush lands when a large majority of the people did not believe that such practices were harmful to soil fertility and felt no responsibility for the land so burned over.

It was agreed that the firing of grass land was in many cases a beneficial and necessary operation—for example to get rid of an over-burden of old grass and weeds. The problem was to limit and control such fires.

TRUST BOARD POLICY

The board expressed the view that, as a long-term measure, the policy of the Native Land Trust Board of leasing out, with fencing conditions, range land excluded from reserve was encouraging tenants to plant better grasses and to conserve their grazing. Members believe that this would discourage the uncontrolled firing of grass.

The board considered that the efforts of the Department of Agriculture to scatter Nadi blue grass seed where fires have taken place should be encouraged. This grass affords fair grazing on hilly country in the dry zone and will not support extensive grass fires. It competes very well with other grasses.

It is believed that the wide establishment of this grass would check the extent of fires.

CONTROL OF FIRES

The board expressed the view that in the enforcement of legislation against indiscriminate firing only the District Administration, Fijian Administration and police acting in collaboration have the resources necessary to bring offenders to task.

It was decided to recommend the experiment of appointing two full-time fire rangers in the Western District to work with the police. The duty of the rangers will be to patrol selected areas, undertaking propaganda in these areas and prosecuting any offenders.

The board agreed that land and water conservation was ultimately dependent on the use of land only for purposes for which it was ecologically suited.

ESSENTIAL FORESTS

In particular, watersheds should be protected by maintaining or establishing forests and by preventing over-grazing. It was not possible for the board to formulate a detailed policy at this stage, but the Conservator of Forests was invited to submit an introductory memorandum for the information of members.

CONSERVATION OF LAND QUESTION FOR NEW BOARD

The Land Conservation Board constituted under the Land Conservation and Improvement Ordinance of 1953 held its first meeting on Tuesday 26th January, 1954, in the office of the Director of Agriculture, who is the chairman.

The official members of the board are the Director of Agriculture, the Director of Public Works, the Director of Lands and the Conservator of Forests.

The five other members appointed by the Governor to hold office for two years in the first instance are Messrs. C. Elliott, S. A. Tetzner, A. D. Patel, Misi Ada Sila and Mr. T. E. Foster.

The functions of the board are:

(1) To exercise general supervision over land and water resources.

(2) To stimulate by propaganda and such other means as it may deem expedient public interest in the conservation and improvement of land and water resources:

(3) To recommend to the Governor the nature of legislation by it deemed necessary for the proper conservation and improvement of land and water resources.

(4) To make conservation and closing orders where it considers that these are expedient.

THE FIJI PLANTERS' JOURNAL 1913-1915

This monthly Journal was not an official or departmental one but was published at Suva for the Planters' Association of Fiji and edited by the Secretary, H. H. Thiele, with a view to providing up-to-date information and to promote "co-operation and a feeling of self-reliance amongst the planters."

The Journal appears to have been a casualty of World War I—and as it is not mentioned in the introductory note to the first number of the official monthly "Agricultural Circular" which commenced in January 1920—it would appear to have been defunct some time before that date. The last available number is Vol. 3, No. 30 published in December 1915.

The issues of this now rare publication available for purposes of this Index comprise only the following nine numbers presented to the writer by the late Mr. Wright of Nukudrau Island Natewa Bay, Cakaudrove.

1913	..	Vol. 1, Nos. 1, 2, 5, 6
1914	..	Vol. 1, No. 10
1914	..	Vol. 2, No. 13
1915	..	Vol. 2, No. 21
1915	..	Vol. 3, No. 25
1915	..	Vol. 3, No. 30

A public appeal for loan of additional copies for use in the present index and numerous enquiries amongst old established planters in the Colony has not been successful, nor is the publication to be found in any of the local libraries.

Although a large part of the subject matter comprises reprints, extracts and reports from overseas sources, there are a number of original contributions from C. H. Knowles, Director, and other members of the staff of the Department of Agriculture, as well as records of meetings of the various branches of the Fiji Planters' Association and of local events which have both an historical and a technical interest.

The advertisements of 40 years ago may be briefly referred to under the following headings, most of the firms having long since ceased to operate in the Colony:—

Produce Agents 7, General Merchants 6, Hardware and Engineering 4, chemists (including insecticides) 3, Fertilizers 2, Saddlery or Harness 1, Stables 1, Newspaper (Fiji Times & Herald) 1 and Grand Pacific Hotel (tariff 12s. per day, £4 4s. 0d. per week).

—B.E.V.P.

BANANA BORER

Recent field experiments on the banana borer, *Cosmopolites sordidus* in Trinidad described by N. W. and F. J. Simmonds[1] deal with the efficacy of Cosmopolocid-109* and with the use of Aldrin and Dieldrin as soil insecticides. It is concluded that the insecticidal treatments are cheaper and more effective, and that the attractiveness of banana pseudostem traps to banana borers is greatest in the first week and thereafter declines.

REFERENCE.

(1) Simmons, N. W. and Simmonds, F. J.—"Expts on the Banana Borer in Trinidad",—Trop. Agric., Vol. xxx, Nos. 10-12, 216-223.

* This is a toxic dust which consists of a finely divided dust as a carrier for chlordane, a trace of parathion and an attractant, 2-phenyl-4-hydroxyquinazoline.

SOILS, SAND AND OTHER POTTING MEDIA*

The capacity of soils to retain moisture varies considerably. A clay loam is more retentive of moisture than a sandy loam. The experienced gardener therefore selects a clay loam for his strong-rooting, large-leaved tropical plants, because transpiration is so much greater in these plants. For a general collection of greenhouse and small-growing tropical plants he selects a good loam. For cacti, agaves, and other succulent plants which will not take as much water at all seasons as other plants, he selects a sandy loam. For ferns, most of the Ericaceae and Gesneraceae, he selects peat; while for nepenthes, orchids, bromeliads, and the epiphytic aroids he selects fern or kalmia root. Other materials which a gardener should always have on hand when he has a large and varied collection of plants are: leaf-mold, which is made by collecting leaves and storing for at least two years, turning them over occasionally to facilitate decay; living or fresh sphagnum moss; sand; charcoal, and some convenient manure such as pulverized sheep-manure and bone-meal.

Growing plants in pots is very different from growing them in borders or the open ground. The experienced gardener digs the turf only from good pasture or meadow land, so that it shall be full of the fibrous roots of the grass. But before using the turf for potting it should be placed in square piles, turf downward, for at least six months in order to kill the grass and all vegetable life. Fern root should also be collected and stored the same length of time in order to kill out the ferns. Raw and very coarse soils are usually sifted before being used for most greenhouse plants. Shallow sieves are used for this purpose.

Except for sowing seeds and for potting seedlings and freshly rooted cuttings, thoroughly decayed and homogeneous soils should not be sifted, but should be broken into small lumps, as the small lumps assist materially in aerating the soil. If the soil is sifted too much it becomes very fine, packs close and allows too little aeration. Leaf-mold is decayed vegetable matter, or humus. It may have little manurial value, but is used by gardeners to make soils "light" or spongy. For most young plants a good proportion added to the soil is excellent as it encourages root-growth.

Sand is the best medium for rooting cuttings of the larger number of plants. It is also added to soils to increase their porosity, especially when potting very young plants. Silver sand is best.

In potting plants, experienced gardeners make potting mixtures or add a variety of materials to the soil to suit the requirements of different plants. For young seedlings or for freshly rooted cuttings, the compost should be of a light and porous nature, but as plants increase in size and vigour a heavier and richer mixture is usually given, that is, if plants are to be grown on as specimens; but the proportion of nutrient substances used in a potting mixture should be determined by the vigour of the plants. It is always better to use too little plant-food than too much. If too much is used it becomes available faster than the roots of plants can absorb it, often with fatal results. Many amateur plant-growers in their over-anxiety to grow fine plants make this fatal mistake.

In most gardens the greenhouse space is limited, and a gardener cannot always develop his plants to their fullest capacity or he has to reduce his variety and numbers. This, then, determines in the mind of an experienced gardener the composition of his potting mixtures. His aim should be to grow the finest possible specimens in the smallest possible pots and space.

* By Edward J. Canning in *The Standard Cyclopedia of Horticulture*

A NOTE ON CREEPING INDIGO*

Indigofera endecaphylla Jacq. (creeping indigo or trailing indigo) seemed promising for a time as a high-rainfall zone legume. Early experiments proved that it would grow well with a wide variety of associated grasses, and grazing test showed that it was palatable and quite persistent under pasture conditions.

Very little was known, on the other hand, of its feeding value for livestock. In 10 years of short-interval pasture trials with relatively small proportions of the legume, no adverse effects were noted on young cattle. However, when the concentration of the legume exceeded about 50 per cent of the forage, toxicity symptoms began to appear. In early 1949, two heifers on lush creeping indigo pastures showed the characteristic of reaction of walking in circles with heads low. These manifesations led to the investigations reported here.

A study of the effect of a strain of *Indigofera endecaphylla* Jacq. (creeping indigo) grown in Hawaii and tested as a feed for cows, heifers, sheep, and rabbits is presented. The following results were obtained:—

1. *Indigofera endecaphylla* used as pasturage in mixture with grasses, or harvested, chopped, and fed ad libitum in a fresh or semi-dry state, caused abortion or still birth in pregnant cows and heifers. The calves were born at normal time or prematurely by as much as 100 days. The abortive effect was found also in preganant does fed as little as 5 per cent dry leaf meal in dry ration.
2. Other symptoms caused by feeding the legume were anorexia, loss of weight, and emaciation. In advanced cases a motor nerve disturbance was manifest: heifers walked in circles; sheep pressed their heads against the fence; rabbits suffered ataxia. In sheep and rabbits a serous discharge from the eyes was observed, and occasionally opacity of the cornea developed. In sheep a purulent nasal discharge and severe diarrhoea were noticed.
3. Feeding the fresh chopped legume to sheep for 28 days killed some of the sheep, while others became so weak that euthanasia was performed. Feeding the fresh legume killed rabbits within 7 to 30 days. Twenty per cent dry leaf meal added to a normal ration killed the rabbits within 30 to 50 days.
4. The most outstanding effect on vital organs was on the liver. Disturbances in the heart, kidneys, and lungs were also noted. In the liver, congestion, fatty degeneration, and cirrhosis occurred. Liver lesions were noticed in an autopsied cow, in a sheep, and in 48 rabbits. Hydrocephalus was found in several rabbits.
5. A study of the pathogenesis in rabbits was made. The early liver changes were degenerative and began during the first week of feeding. The hepatic cells in the portal region became swollen and granular, later vacuolated, and finally necrotic. The process started at the portal triads and extended toward the central vein. By the end of the second week, the lesions were becoming proliferative instead of degenerative in nature. The necrotic hepatic cells were being replaced by connective tissue and bile ducts. By the third week the lesions were chiefly proliferative, with the normal lobular structure obscured by large formations of connective tissue and bile ducts. Passive congestion of the kidneys and lungs developed during the second week of feeding. All cases of hydrocephalus developed between 18 and 25 days after the feeding of creeping indigo was started. After 3 weeks no additional lesions were found.
6. No effect of the legume on hemoglobin could be established in heifers, sheep, and rabbits. Neither was there any effect noted on erythrocytes, leucocytes blood sugar, and blood calcium in heifers and sheep. A slight decrease in serum phosphorus was noticed for heifers and sheep.
7. A study of the urine in sheep and rabbits revealed increased amounts of urinary ammonia, total nitrogen, and indican, and a decrease in pH values.

* Feeding Tests with *Indigofera endecaphylla* Jacq. and some observations on its poisonous effect on Domestic Animals by S. Nordfeldt and others. Tech. Bull. 15 July, 1952—Univ. of Hawaii Agr. Expl. Stn.

ADVISER SPEAKS TO FIJIANS*

I am impressed with the great potential resources of the Colony of Fiji—the farmers here are very fortunate because there are few diseases of crops or animals. It is the duty of the people to use these resources as wisely as possible.

You Fijians are fortunate as you still have abundant land for development. In the Colonies generally, wealth production lies in the hands of the small peasant farmer or with the "*dau teitei teitei lalai*". The problem is how best to keep your traditional customs and how to fit them in with economic development. Fiji has a favourable climate and soil suitable for a wide range of productive crops and in some areas to animal production.

In permanent tree crops as coconuts, cacao, coffee and sugar, Fijians have crops which lend themselves to community cropping and are therefore favoured. In particular in Viti Levu bananas are being developed as the source of wealth, because they lend themselves to both community and individual development.

Earth is the Mother of all things. It is up to the Fijian people who own large areas of land to protect that earth and use it properly so that succeeding generations may bless the present generations for their care of the land and its resources.

* Sir Geoffrey Clay, K.C.M.G., O.B.E., M.C., at Fijian Ceremony of Welcome, Nasekula, Labasa, Macuata, 22–2–54.

FLAVOUR IN MILK

Workers at the Pennslyvania Experiment Station have discovered that the cause of the unpleasant flavour and vitamin loss of milk which stands in daylight in ordinary glass bottles is due to the fact that methionine is changed chemically under the action of solar energy. In the course of the reaction, a substantial portion of the B vitamin, riboflavin, is destroyed. Most of the vitamin C in milk is also destroyed if the milk is exposed to daylight in glass bottles for half an hour or more, but the report does not state whether this is related to the methionine change. The specific nature of the change in methionine under the action of solar light and riboflavin is now being investigated.

2, 4, 5—T

2, 4, 5–T can be used in other ways than spraying to kill trees and tree stumps. It will mix readily with fuel oil or TVO, and can then be applied as either a low pressure spray or by means of an ordinary paint brush. For spraying, painting, or pouring, to wet the lower foot or so of the tree trunk and any exposed roots, it should be mixed at the rate of about 5 fluid ounces of a mixture containing 4 lb of 2, 4, 5–T per gallon of oil. For stump treatment 3 fluid ounces per gallon of oil is sufficient and it is only necessary to wet the bark surface of the stump and any exposed roots. For spraying low-growing dense scrub, 1 fluid ounce per gallon of water is used.

Wetting the trunks of trees to a height of one to two feet above ground level with an oil solution of 2, 4, 5–T gives better results than foliage sprays, and, of course, has several advantages. There is very little risk of drift, such as is encountered with a spray; the work can be carried out at any time of the year and with very cheap equipment, such as an old paint brush or a swab of rags.

BLACK PEPPER

An article by J. S. Blacklock[1] provides a useful short account of the methods of cultivation, propagation and culture of pepper common in the Malay archipelago and Indochina. The history of the crop and its botanical and varietal characteristics are described. Soils are discussed briefly. Pepper requires a soil well drained and free from excessive moisture—the ideal being well-drained alluvium with a fairly high humus content; although in Sarawak practically all the pepper gardens are located on undulating " rolling country or hillslopes of heavy reddish-brown clays with a high sesquioxide content "—Burnt earth and wood ashes were used as a fertilizer formerly: but in Sarawak it has been found that pepper requires " a highplane of well balanced nitrogenous manuring if fruit production is to be kept at an economic level: guano up to 5 lb vine, prawn and fish refuse, 2–5 lb per vine or bean cake, 3–5 lb per vine are applied three times a year." Details of inorganic fertilizers and cultivation methods are given; pests and diseases are described and harvesting and processing discussed. Yields are variable rising from 2½ lb of " green pepper " per vine in the third year to 20 lb during the fourth to seventh years. It is estimated that 100 lb of green pepper will give 25 lb of dry white pepper or 37 lb dry black pepper after processing. The article should be of considerable use to readers interested in growing this crop.

AGRICULTURE IN PAPUA—NEW GUINEA

Readers throughout Fiji, the South Pacific and beyond will welcome the reappeaarnce of a Journal* which has, owing to enemy action and subsequent events, been out of circulation for over ten years.

The Department of Agriculture Livestock and Fisheries in the territories of Papua and New Guinea is to be congratulated on the decision to produce in a new series the Gazette which formerly held a high reputation for the quality and all-round value of its contributions to agricultural knowledge in the region.

The first two numbers of Volume 8 have now appeared and may be recommended to all readers interested in the new efforts being made to develop agricultural production and industry on scientific lines. Amongst many articles of special significance at the present time are those dealing with the " Relationship between Cacao yield and rainfall " by L. A. Bridgland, " Vegetative propagation of Cacao " by R. J. Harris, " The Rubber Industry " by C. E. T. Mann and " The prospects for tea production " by G. T. Newton.

Mr. R. E. P. Dwyer, one of the four remaining members of the pre-war Department provides a valuable preliminary account of the important fungus and physiological diseases affecting the coconut palm: and a note by Mr. G. S. Dun gives interesting new information on plantation hygiene and the rhinoceros beetle.

There are also valuable contributions on the new fibre, kenaf—on copra marketing, prices and quality and useful information on coffee growing and an account of the grazing industry in the territory.

—B.E.V.P.

* The Papua and New Guinea Agricultural Gazette (New Series), published quarterly July–October, 1953. Vol. 8, Nos. 1 & 2 Annual Suscription 6s.

THE FIJI SOCIETY

Towards the end of 1953 the Council of the Fiji Society announced the publication of three volumes of the Transactions* which had been delayed for over a period of ten years owing to conditions arising from World War II. The papers read during the period, which are now available for information and study, deal with many subjects of value and concern to farmers, planters and all good Colonists, covering as they do the fields of anthropology, botany, geology, meterology and zoology: and there are several accounts of early planting enterprise and development work of great interest. A few titles only can be listed: " Banana Breeding " by Dr. K. Dodds, " Sugar Cane Improvement " by J. Trivett, " Use of Fish Poison Plants ", by H. Gatty, " Soils of Humid Tropics' by W. J. Blackie, " Hurricanes and Forecasting Problems " by W. R. Dyer; and papers by R. J. A. W. Lever on Fiji Fauna. There are contributions dealing with the weeds and alien plants of the Colony-forestry, Weed Control and other scientific problems and, of course, a unique series of papers of historical and anthropological importance.

* " Transactions of Fiji Society ", Vols. II, III & IV 1940–1950—Published under authority of the Council of the Fiji Society Price £3 3s. 0d. a set.